The Evaluation of Mobile and Stationary Facilities for the Destruction of PCBs

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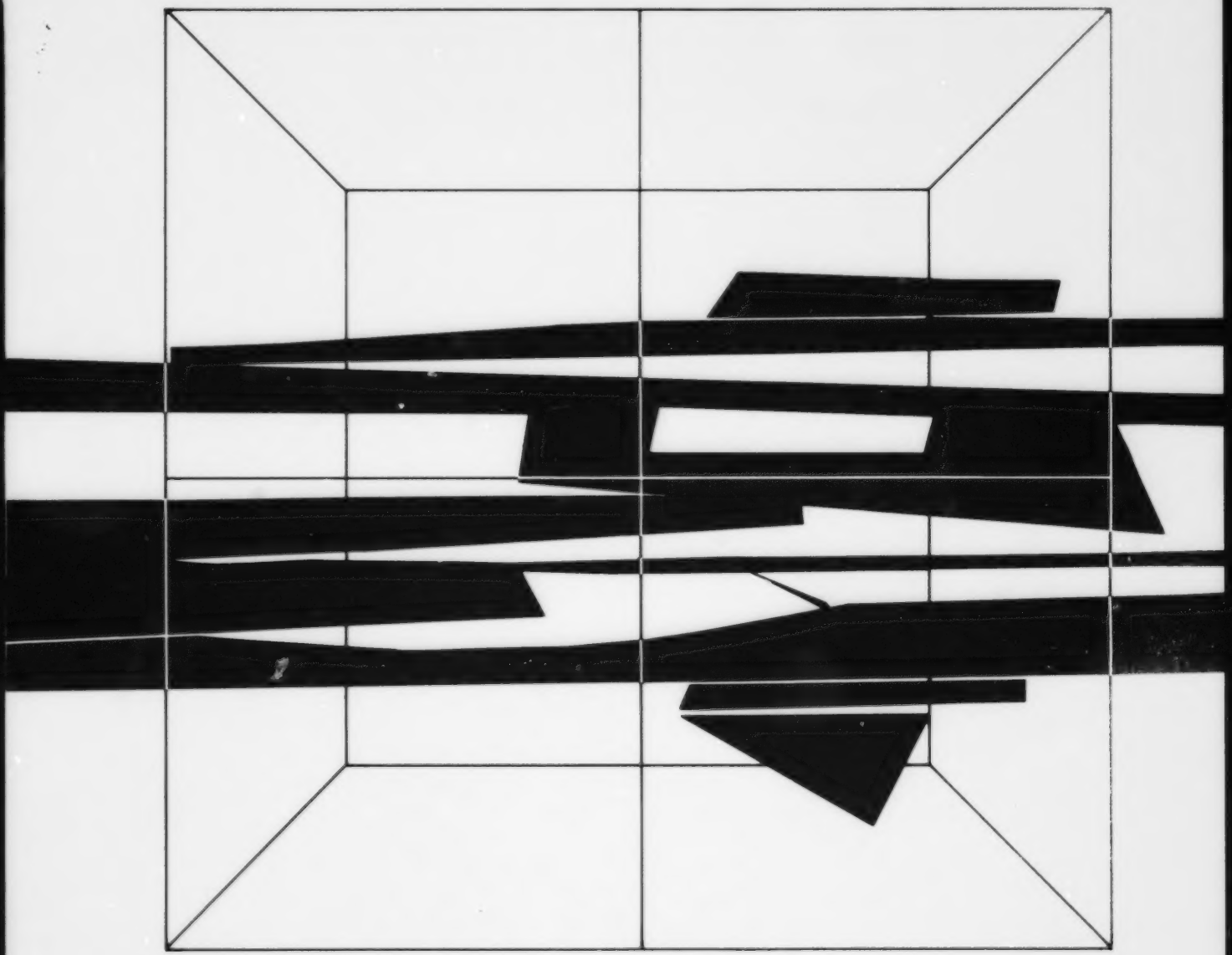
May 1989



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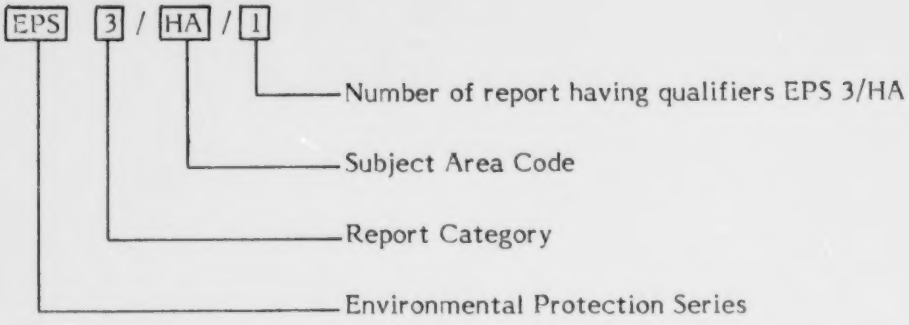
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THE EVALUATION OF MOBILE AND STATIONARY FACILITIES FOR THE DESTRUCTION OF PCBs

by

P. Piersol
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for

Environment Canada

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ABSTRACT

This report provides an up-to-date appraisal of polychlorinated biphenyl (PCB) destruction technologies. Over 60 companies and organizations were surveyed to obtain information on processes that destroy PCBs contained in both liquid and solid wastes. The information was reviewed, the technologies evaluated and the status of each technology identified as commercial, near-commercial or promising.

Stationary rotary kiln incineration with flue gas treatment has been proven commercially at several U.S. and European facilities. Three stationary industrial hazardous waste facilities which will incinerate PCB wastes are under development in Canada. Eight North American companies were identified that offer near-commercial mobile/transportable destruction technologies. Mobile, sodium-based and PEG/KOH (poly(ethylene glycols)/potassium hydroxide) processes for the decontamination of PCB-contaminated oil are considered proven commercial PCB destruction technologies. Four companies operate mobile facilities using PCB-contaminated oil dechlorination technologies in Canada. Promising technologies for the treatment of PCB solid wastes are low-temperature oxidation, chlorine removal, vitrification, biodegradation and thermal extraction.

RÉSUMÉ

Le présent rapport porte sur les techniques actuelles de destruction des biphényles polychlorés (BPC) contenus dans des déchets liquides et solides. L'information de base sur ces techniques a été obtenue auprès de plus de 60 entreprises et organismes. Un examen de l'information a permis d'évaluer les techniques existantes et de faire le point sur leur développement: elles existent au stade commercial, au stade pré-commercial et au stade de la mise au point (à fort potentiel).

L'incinération en installation fixe dans un four rotatif avec traitement des gaz de carneau a fait ses preuves dans plusieurs entreprises américaines et européennes. C'est pourquoi trois usines de traitement des déchets industriels dangereux pour l'incinération des BPC sont en voie de réalisation au Canada. Il existe en Amérique du Nord huit entreprises qui possèdent des installations de destruction mobiles ou transportables au stade pré-commercial. La décontamination des huiles contenant des BPC à l'aide des procédés au sodium et au PEG/KOH (glycols de polyéthylène/potasse) est considérée comme une Technique éprouvée dans les installations mobiles commerciales. Quatre entreprises exploitent des installations mobiles de déchloruration des huiles contaminées par des BPC au Canada. Les techniques les plus prometteuses pour le traitement des déchets solides de BPC incluent l'oxydation à faible température, la déchloruration, la vitrification, la biodégradation et l'extraction thermique.

TABLE OF CONTENTS

		Page
ABSTRACT		iii
LIST OF TABLES		vi
NOTICE		vii
SUMMARY		viii
1	INTRODUCTION	1
2	PROGRAM SCOPE AND SOURCES OF INFORMATION	2
3	AVAILABLE TECHNOLOGIES	4
3.1	Evaluation Criteria	4
3.2	Technology Evaluation	5
3.2.1	Stationary PCB Destruction	6
3.2.2	In-house PCB Destruction	11
3.2.3	Mobile/Transportable PCB Destruction	13
3.2.4	At-Sea Incineration	16
3.2.5	Mobile Oil Treatment Processes	17
3.2.6	Alternative PCB Solid Waste Treatment	19
4	CONCLUSIONS	22
REFERENCES		23
APPENDIX	PCB DESTRUCTION TECHNOLOGY DATA SHEETS	27

LIST OF TABLES

Table		Page
S.1	SUMMARY OF THERMAL PCB DESTRUCTION TECHNOLOGIES	ix
S.2	SUMMARY OF CHEMICAL PCB DESTRUCTION TECHNOLOGIES	x
S.3	SUMMARY OF ALTERNATIVE PCB SOLID WASTE TREATMENT TECHNOLOGIES	x
1	PCB DESTRUCTION TECHNOLOGIES SURVEYED	7
2	SUMMARY EVALUATION: THERMAL PCB DESTRUCTION TECHNOLOGIES	12
3	SUMMARY EVALUATION: CHEMICAL PCB DESTRUCTION TECHNOLOGIES	20
4	SUMMARY EVALUATION: ALTERNATIVE PCB SOLID WASTE TREATMENT TECHNOLOGIES	21

NOTICE

This report on the evaluation of PCB destruction technologies is an update of a previous report on this subject, which was prepared jointly under contract with Environment Canada by ORTECH Corporation, Envirochem Services and Monenco Consultants Limited.

The report has been reviewed by the Technology Development and Technical Services Branch, Environment Canada, and approved for publication. Approval does not necessarily signify that the contents reflect the views and policies of Environment Canada. Mention of trade names or commercial products does not constitute recommendation or endorsement for use.

READERS' COMMENTS

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SUMMARY

This report identifies and evaluates existing polychlorinated biphenyl (PCB) destruction technologies suitable for immediate application in Canada. Operating requirements, performance, economics, and other pertinent characteristics of the various technologies are given, with emphasis on mobile technologies to destroy wastes containing relatively high concentrations of PCBs.

Three categories of destruction technologies are defined. A commercial technology is defined as one that has successfully destroyed PCB-containing wastes under sustained routine field conditions for at least one year in Canada or elsewhere. A near-commercial technology is defined as one for which a permit application for commercial operation has been submitted in a North American jurisdiction. A third technology category, promising, is also identified. The availability of information for all technology categories depended on the development status of the technology, the status of the regulatory permit process, and the willingness of companies to release technical and economic data.

Technologies for the destruction of PCB wastes are classified as thermal destruction, which is either stationary, mobile/transportable, or incineration-at-sea; chemical oil treatment; and alternative PCB solid waste treatment.

Tables S.1, S.2 and S.3 list the PCB destruction technologies evaluated by category and classification.

The status of the PCB destruction technologies can be summarized as follows:

Stationary Destruction Technologies

- Stationary rotary kiln incineration with flue gas treatment has been proven for PCB destruction at several American and European facilities. These facilities have operated in the U.S. since 1981 and in Europe since 1975 and have undergone extensive regulatory monitoring and assessment during the successful destruction of all types of PCB wastes.
- Three stationary industrial hazardous waste facilities are under development in Canada: the Alberta Special Waste Management Corporation, the Ontario Waste Management Corporation (OWMC), and the Selenco/Sanivan Group (Quebec). It is anticipated that the Alberta facility will commence commercial treatment of Alberta PCB wastes in 1988. The Selenco/Sanivan Group are planning to receive Canadian PCB wastes in 1988 and to commence commercial destruction in 1990.

TABLE S.1 SUMMARY OF THERMAL PCB DESTRUCTION TECHNOLOGIES

PCB Destruction Technologies	Commercial	Near-Commercial	Promising/ Developing
Stationary	- Ensco Environmental Services - Hessian Industrial Waste Inc. (HIM) - Kommunekemi - Pyrochem - ReChem International (IEM Corp.) - Rollins Environmental Services - SAKAB - SCA Chemical Services	- Alberta Special Waste Management Corp.* - Arc Technologies Co. - Selenco/Sanivan Group*	- Ontario Waste Management Corp.*
Mobile/ Transportable		- Ensco Environmental Services MWP2000 - Haztech, Inc.* - IT Corp. - Ogden Environmental Services, Inc. - O.H. Materials, Inc.* - Riedel Environmental Services* - Selenco/Sanivan Group* - Shirco Infrared Systems, Inc.	- Vesta Technology Ltd. - Westinghouse Electric Corp.
Incineration at Sea		- Chemical Waste Management, Inc.	

* Organizations that propose to operate PCB destruction technologies designed and constructed by others. These organizations are not proponents or developers of specific technologies.

TABLE S.2 SUMMARY OF CHEMICAL PCB DESTRUCTION TECHNOLOGIES

PCB Destruction Technologies	Commercial	Near-Commercial	Promising/Developing
Stationary Oil Treatment	- PCB Eliminators - PPM Canada, Inc. - Trinity Chemical Co.		
Mobile Oil Treatment	- Chemical Decontamination Corp. - Chemical Waste Management, Inc. - Excel Tech Inc. - PPM Canada, Inc. - Rondar, Inc. - Selenco/Sanivan Group - Sun Environmental Ltd. - Transformer Consultants	- General Electric Co. - IT Corp. - Ozonics Technologies Inc.	

TABLE S.3 SUMMARY OF ALTERNATIVE PCB SOLID WASTE TREATMENT TECHNOLOGIES

PCB Treatment Technologies	Commercial	Near-Commercial	Promising/Developing
Biodegradation	- Detox Industries, Inc.		- Bioclear Corp.
Chlorine Removal			- Galson Research Corp.
Low Temperature Oxidation			- Modar, Inc.
Solvent Extraction			- Acurex - O.H. Materials, Inc.
Thermal Extraction			- SRH Associates, Inc.
Vitrification			- Battelle Pacific Northwest Laboratory

The commercial treatment of Ontario PCB wastes is scheduled to commence in 1991 at the OWMC facility.

Mobile/Transportable Destruction Technologies

- Eight North American companies have near-commercial mobile/transportable destruction technologies. Rotary kilns and circulating bed combustors are capable of handling liquid and solid PCB wastes. The infrared system can currently treat only PCB-contaminated soils and sludges. The plasma pyrolysis system can handle only liquid PCB wastes.

Incineration at Sea

- Ocean Combustion Service, a subsidiary of Chemical Waste Management, Inc., offers commercial PCB destruction to the European market. This company does not have a permit to operate in Canada or the U.S. Chemical Waste Management, Inc. have been negotiating with the U.S. Environmental Protection Agency for a permit and the Vulcanus I and II vessels are considered near-commercial in North America.

PCB-Contaminated Oil Treatment

- Mobile, sodium-based and PEG/KOH-based processes for the decontamination of PCB-contaminated oil are considered to be proven PCB destruction technologies. Treatment of oils with PCB concentrations exceeding 10 000 ppm is generally not economical. Four companies operate chemical treatment technologies in Canada.

Alternative PCB Solid Waste Treatment Technologies

- Alternative technologies to thermal destruction are being developed for the treatment of solid PCB wastes. Those considered promising are low temperature oxidation, chlorine removal, vitrification, biodegradation and thermal extraction.

1 INTRODUCTION

The development of hazardous waste management programs by government and industry has emerged in recent years as a national priority. Although a number of technologies have proven effective in destroying PCB wastes, and others have been proposed, the need for an up-to-date review and critical assessment of available PCB destruction technologies was identified. This report was prepared in response to that need and was undertaken as a project under the Canadian Council of Resource and Environment Ministers (CCREM) Action Plan.

PCBs have been, and continue to be, used primarily as dielectric fluids and coolants for electrical equipment and in a variety of lesser applications(1). Regulatory restrictions on the use of PCBs in Canada were initiated in 1977 with the Chlorobiphenyl Regulations No. 1, enacted under the Environmental Contaminants Act(2). These regulations restricted the use of PCBs to in-service and new electrical capacitors, electrical transformers, and associated switchgear. They also restricted use to in-service heat transfer equipment, hydraulic equipment, electromagnets and vapour diffusion pumps. In 1980, an amendment to the Chlorobiphenyl Regulation No. 1(3) prohibited the use of PCBs in new equipment and further restricted the use of PCBs in existing equipment. Effective August 1, 1985, the Chlorobiphenyl Regulation No. 2 (Product)(4) limited the maximum concentrations of PCBs (50 ppm) in specified electrical equipment when imported, manufactured or sold.

These regulations have prevented the introduction of new equipment containing PCBs and the upgrading of old equipment with new PCB fluids. The concentration of greater than 50 ppm by weight of PCBs is used to define a PCB waste that requires treatment. The primary source of PCB wastes is PCB equipment which is taken out of service. To date, the phasing-out of PCB equipment has not been regulated.

The present Canadian PCB inventory(1) indicates that significant quantities of PCB wastes require destruction and that one or more technologies are needed to handle PCB wastes such as:

- transformer and capacitor fluids containing high concentrations of PCBs,
- contaminated mineral oils containing low concentrations of PCBs,
- capacitor and other electrical equipment casings, cores and windings,
- containers used to hold PCB wastes,
- sludges, aqueous suspensions, rinsings and solvents, and
- contaminated soils, rags and other solid materials.

2 PROGRAM SCOPE AND SOURCES OF INFORMATION

This report provides a comprehensive review of available PCB destruction technologies, including current information on processes that destroy PCBs contained in both liquid and solid wastes (e.g., oils, aqueous suspensions, sludges, soils, and capacitors). Highest priority was assigned to mobile facilities for the destruction of high concentration PCB wastes, and to the identification of commercial and near-commercial facilities that can be applied immediately and are most promising for use in Canada. Less emphasis was given to other technologies (e.g., non-dedicated waste destruction facilities and incineration at-sea) for which only general information was obtained.

Selection criteria were established to identify and efficiently gather information on commercial and near-commercial PCB destruction technologies. For the purposes of this report, a commercial technology is defined as one that has successfully operated commercially for at least one year on PCB waste. Near-commercial technology is one for which a permit application to destroy PCB wastes has been submitted. For the United States, identification of these technologies was undertaken by obtaining U.S. Environmental Protection Agency (EPA) lists of permitted PCB destruction facilities and those technologies for which permit applications have been submitted. A third category of PCB destruction technologies was also defined for data gathering purposes. This category, defined as promising or developing technologies, encompasses those technologies that do not satisfy the definitions for commercial and near-commercial technologies, but nevertheless should be referenced since some of them may enter the near-commercial category in the near future.

Data gathering was undertaken for all three technology categories, but with an overall priority given to mobile facilities capable of destroying high concentration PCB wastes. In addition to U.S. EPA permit lists, Canadian provincial environment agencies and American and European technology proponents were contacted, and reports and publications on PCB destruction technologies[5-12] were reviewed to supplement the initial technology list.

Where appropriate and feasible, information was requested from the technology proponents on the following topics:

i) a description of the process, including process design specifications such as waste types accepted, feed rate, and destruction efficiency;

ii) monitoring aspects, including both process control and emission monitoring;

iii) emergency shutdown procedures and other safety features;

iv) description of operating data, including process stream emissions, potential fugitive emissions, operational requirements, economic factors, minimum and maximum throughput quantities, manpower requirements, run duration, and susceptibility to climatic conditions;

v) demonstration test results;

vi) development stage (commercial, near-commercial);

vii) destruction efficiency and overall performance characteristics;

viii) mobility features;

ix) names of contact personnel for each technology;

x) approvals received for commercial units and conditions for operation; and

xi) costs for PCB waste destruction.

Contacts were made with individuals by telephone or by personal meetings. To facilitate discussions with technology proponents, a list of key parameters was assembled. If a company requested further clarification of the type of information required, this list was then forwarded to that company.

The amount of information available was found to depend on such factors as the development status of the technology, the status of regulatory permitting, and the willingness of the companies to release technical and economic data.

3 AVAILABLE TECHNOLOGIES

3.1 Evaluation Criteria

In order to identify PCB destruction technologies most suitable for immediate application in Canada, several technology evaluation criteria were established. These criteria were used to select commercial, near-commercial and promising PCB destruction technologies from a long list of candidate technologies that were surveyed.

- **Operational status**

  To be categorized as "commercial", the technology must have operated successfully under sustained routine field conditions at a commercial scale for at least one year. Appropriate process control and shut-down systems must have been in place and demonstrated for effectiveness and reliability during the time of commercial operation.

  To be categorized as "near-commercial", an application for commercial operation (full-scale or pilot scale) must have been under review by government agencies in North America, or trial burns must have been under way.

  To be considered as "promising", the technology should have reached the stage of development such that it was considered that it could be applied to the commercial destruction of PCB wastes in less than two years.

- **Regulatory approval**

  Regulatory agency approval must have been obtained for the destruction of PCB wastes. These regulations usually stipulate process performance requirements. For example, the U.S. EPA requirement for the incineration of PCB solid wastes, is that PCB mass air emissions must be no greater than 1.0 milligram PCB per kilogram of PCB introduced to the incinerator. Similarly, for chemical treatment technologies, the PCB content of the decontaminated mineral oil must be less than 2 ppm.

- **Waste types accepted**

  The technology must have operated on PCB wastes representative of one or more of the actual PCB waste types and forms which require destruction in Canada, for example, PCB-contaminated oils, sludges, soils and solids and/or capacitors.

- **Canadian availability**

  The technology must be available for immediate application in Canada, within the constraints of the permit procedure in the jurisdiction of interest. Foreign technology must have been demonstrated to be accessible through a Canadian corporate office or agent.

- **Performance documentation**

  The operation of the technology must have been clearly demonstrated and documented. For incinerators, this demonstration would have included appropriate monitoring and assessment to verify that emissions of PCBs, polychlorinated dibenzofuran (PCDFs), polychlorinated dibenzo-*p*-dioxin (PCDDs) and other pollutants are within acceptable limits. The process must have been tested at the maximum specified feed rates and associated PCB concentrations with satisfactory performance.

  Appropriately documented and complete information and data had to be readily obtainable to confirm compliance with the afore-mentioned criteria.

All technologies identified were assessed from available information using the above criteria. Technologies with regulatory approval that had operated for one or more years were automatically classified as commercial. The first four criteria were used to evaluate and select commercial, near-commercial and promising technologies from the complete listing of technologies surveyed for potential application in Canada. Performance documentation, mobility features and economic factors were used in conjunction with the first four criteria to evaluate further the development, approval and potential for the immediate application of a technology in Canada.

3.2 Technology Evaluation

PCB waste treatment and destruction technologies may be classified into the following types:

- thermal destruction,
- chemical dechlorination, and
- solvent extraction.

Thermal technology has been used for the destruction of many hazardous organic compounds including PCB wastes. The various types of incineration systems

include rotary kilns, liquid injection, and alternative thermal systems such as infrared energy, plasma arc, molten bed reactors and circulating bed combustion. These thermal technologies can be stationary, transportable or mobile.

Chemical dechlorination is widely used for the destruction of low-level PCB liquid wastes. This technology is usually used in the mobile mode to conduct on-site decontamination of PCB-contaminated mineral oil in bulk or in electrical equipment. Treatment of oils with PCB concentrations exceeding 10 000 ppm is usually technically possible but not economical.

Recently, solvent extraction technologies have been developed which can be used to remove PCBs from solid wastes such as contaminated soils, or to flush electrical equipment to remove high level PCBs. Solvent extraction is not a destruction technology but rather a treatment procedure which will remove the PCBs from the material or equipment of concern. The solvent wash solution which contains PCBs requires further treatment by thermal incineration or chemical dechlorination to finally destroy the PCBs.

In addition to these established technologies, research is being conducted to develop alternative processes for the treatment of PCB solid wastes such as soils, sludges and sediments.

A list of all technologies surveyed, by process type, is presented in Table 1. The technology types in Table 1 are stationary incineration, in-house incineration, mobile/transportable, incineration-at-sea, stationary and mobile oil treatment, and alternative PCB solid waste treatment. The in-house incineration was identified as separate from stationary commercial because technologies of this type accept only specific in-house PCB wastes, not the range of PCB wastes anticipated at a commercial facility.

3.2.1 Stationary PCB Destruction. All the commercial, stationary PCB destruction processes utilize rotary kiln incinerators. Rotary kiln incinerators are preferred over other incinerator types such as liquid injection, multiple hearth and molten salt incinerators because of their ability to handle both liquids and solid wastes either alone or in combination. The PCB rotary kiln incinerators have secondary combustion chambers after primary combustion in the rotary kilns. Primary and secondary combustion chamber operating temperatures are typically between 1100°C and 1300°C. Gas-phase residence time in the combustion chamber varies from less than one to several seconds. Flue gases contain hydrochloric acid (from the combustion of chlorinated organic wastes),

TABLE 1 PCB DESTRUCTION TECHNOLOGIES SURVEYED

PCB Destruction Technology	Companies/Organizations
Stationary Incineration: Rotary Kiln	Ensco Environmental Services Hessian Industrial Waste Inc. (HIM) Kommunekemi Ontario Waste Management Corp. Pyrochem Rollins Environmental Services SAKAB SCA Chemical Services Selenco/Sanivan Group
Stationary Incineration: Other Thermal	Alberta Special Waste Management Corp. Arc Technologies Co. Chem Security Ltd. International Environmental Materials Corp. Los Almos National Laboratory ReChem International Ltd. Rockwell International Energy Systems
In-house Incineration: Liquid Injection	Dow Chemical Co. General Electric Co. LaPorte Chemical Corp. Vulcan Materials Co.
In-house Incineration: Other Thermal	Aluminum Co. of America Tennesse Eastman
Mobile/Transportable: Rotary Kiln	Ensco Environmental Services EPA - Office of Research and Development IT Corp. M&S Engineering Sitex Vesta Technology Ltd. Weston
Mobile/Transportable Incineration: Liquid Injection	Ensco Environmental Services
Mobile/Transportable Incineration: Other Thermal	Drycor Industries GA Technologies Haztech, Inc. J.M. Huber Corp. Ogden Environmental Services O.H. Materials, Inc. Riedel Environmental Services Rockwell International Systems Shirco Infrared Systems, Inc. Selenco/Sanivan Group Westinghouse Electric Corp.

TABLE 1 PCB DESTRUCTION TECHNOLOGIES SURVEYED (Cont'd)

PCB Destruction Technology	Companies/Organizations
Incineration-at-Sea: Liquid Injection	Chemical Waste Management, Inc. Environmental Oceanic Services Seaburn, Inc.
Stationary Oil Treatment: Sodium Process	PCB Eliminators PPM Canada, Inc. Trinity Chemical
Mobile Oil Treatment: Sodium Process	Chemical Decontamination Corp. Chemical Waste Management, Inc. Excel Tech, Inc. PPM Canada, Inc. Rondar, Inc. Selenco/Sanivan Group Sun Environmental Transformer Consultants
Mobile Oil Treatment: Other Processes	General Electric Co. IT Corp. Niagara Mohawk Power Corp. Ozonics Technology, Inc.
Alternative PCB Solid Waste Treatment	Acurex Battelle Pacific Northwest Laboratory Bioclear Corp. Detox Industries, Inc. Galson Research Corp. O.H. Materials, Inc. Modar, Inc. SRH Associates, Inc.

particulates, and metals from inorganic contaminants in the kiln waste feed. Flue-gas treatment systems are employed to remove these contaminants.

Four U.S. companies (Ensco Environmental Services, Pyrochem, Rollins Environmental Services and SCA Chemical Services), operate commercial rotary kiln, stationary PCB destruction facilities. Although these companies accept all forms of PCB waste from any U.S. location, they do not accept Canadian wastes because of the border closure to PCB waste transport by U.S. law.

The trial burns for U.S. EPA certification of these rotary kilns for commercial PCB destruction included monitoring and risk assessment of emissions of toxic combustion by-products (dioxins and furans). The air emissions from these facilities were considered acceptable by the U.S. EPA.

In addition to the four United States companies, three European hazardous waste treatment operations destroy PCB wastes by rotary kiln incineration. These are Hessian Industrial Waste Inc. (HIM) in West Germany, Kommunekemi in Denmark, and SAKAB in Sweden.

These European commercial facilities are large national hazardous waste treatment facilities which handle both organic and inorganic hazardous industrial wastes. Organic wastes, including PCBs, are destroyed in large rotary kiln incinerators whose capacities are of the order of 6 to 12 tonnes per hour. PCB wastes are only a small portion of the total organic wastes destroyed. These facilities accept only wastes from within the country in which they are located, and operate under their respective national environmental regulations. Emission monitoring was conducted at the HIM facility at Biebeshiem during the destruction of PCB and non-PCB chlorinated wastes. Emissions of dioxins and furans were 0.57 ng/m^3 and 16.2 ng/m^3, respectively. There was also no difference in dioxin and furan emissions between the firing of PCB wastes and non-PCB chlorinated wastes.(13)

A significant amount of experience has been obtained in the incineration of PCB-containing wastes at stationary rotary kiln incineration facilities in the United States and Europe. Destruction and removal efficiencies for PCBs at these facilities have been measured at greater than 99.9999 percent. The concentrations of dioxins and furans in the flue gas (less than 1 ng/m^3 to 50 ng/m^3) during the destruction of PCBs have been considered acceptable by the U.S. EPA and European authorities. These facilities operate under government approval, have operated commercially for more than one year and have handled PCB wastes in the form of liquids, sludges, and drums containing PCB wastes and capacitors.

The support systems and residue disposal capabilities for these stationary facilities include extensive receiving, storage and waste material transfer systems plus treatment systems for liquid effluents and solid residues.

In Canada, construction of the ASWMC facility (Swan Hills, Alta.) is complete. Two other facilities are under development, one by the Ontario Waste Management Corporation and the other by Selenco/Sanivan. These facilities are designed for treatment of both organic and inorganic hazardous wastes by incineration and physical/chemical treatment.

The ASWMC facility employs two Von Roll rocking kilns to incinerate organic wastes including PCBs (Table A-7). Each kiln can handle wastes in 200-litre drums and the combined total destruction capacity will be 1400 kilograms per hour. The two kilns discharge to a common air pollution control system comprising a quench tower followed by a series of wet scrubbers. The ASWMC facility has been built and will be operated by Chem-Security Ltd. The facility has been issued a permit to conduct trial burns by the Alberta Department of the Environment.

The OWMC facility will use one Von Roll rotary kiln, with future provision for a second if required (Table A-12). The design capacity of each kiln is 4280 kilograms per hour. Preliminary engineering is complete and OWMC is presently preparing an environmental assessment.

The Selenco/Sanivan Group have proposed a facility in Senneterre, Quebec, for the storage and destruction of organic hazardous wastes including PCBs (Table A-17). The site has approval from the Quebec government for the storage of hazardous wastes. The facility was scheduled to receive waste shipments starting in the first quarter of 1988 and to begin destruction of wastes including PCBs in 1990. High concentration PCB wastes and solids will be incinerated in a rotary kiln and PCB-contaminated mineral oil (less than 3300 ppm) will be destroyed with a chemical dechlorination process.

Arc Technologies are developing a pyrolytic system for the destruction of PCB-filled capacitors (Table A-8). Unopened capacitors are fed into a sealed DC arc furnace where organic materials pyrolyze and inorganic materials melt to form a molten pool in the furnace. This technology was developed in association with the Electric Power Research Institute to handle PCB capacitors from U.S. utilities. The system is designed to handle up to 11 000 kg/h of PCB-filled capacitors. Applications have been submitted for a U.S. Toxic Substances Control Act permit and trial burns were scheduled for October 1987. Although this technology is considered near-commercial, the facility in Model City, New York, is not accessible to Canadian PCB wastes.

In addition to the three Canadian stationary destruction facilities, a Canadian company, International Environmental Materials Corporation (IEM Corp.) offers a PCB disposal service (Table A-15). IEM Corporation ships Canadian PCB wastes to the ReChem International Limited hazardous waste incinerator in Pontypool, Wales, for destruction. These shipments are conducted under the Transportation of Dangerous Goods Act and the International Maritimes Goods Code. The import of wastes into Great Britain and the incineration of these wastes are permitted under U.K. legislation, Control of Pollution (Special Waste) Regulations 1980. IEM Corporation has been offering this service since 1986.

A summary of the evaluation of stationary PCB destruction technologies is presented in Table 2.

Cofiring of hazardous wastes in cement kilns is an attractive alternative to incineration because it makes use of the heat content of the waste. Cement kilns provide temperatures and residence times similar to those required for incinerators dedicated to hazardous wastes. Cement kilns operate at temperatures greater than 1100°C, have gas residence times exceeding 1.5 seconds, and have a highly turbulent combustion zone. In addition to the savings derived from the heat value, using existing equipment saves the capital costs required to build a separate incinerator. A limitation of using cement kilns for waste incineration is that the waste must not have an adverse affect on the cement product.

In 1975/76, an experimental program was conducted at the St. Lawrence Cement Co., Mississauga, Ontario to evaluate the use of a rotary cement kiln to destroy chlorinated liquid wastes. The technology was successful in destroying wastes with up to 50 percent PCBs. However, in spite of this success, further development was cancelled because of a strong negative public reaction.

3.2.2 In-house PCB Destruction. Six U.S. companies (Aluminum Co. of America, Dow Chemical Co., General Electric Co., La Porte Chemical Corp., Tennessee Eastman, and Vulcan Materials Co.) operate, or have operated, eight stationary PCB destruction systems for on-site disposal of in-house PCB liquid wastes. In all cases, these systems are part of the companies' in-house waste disposal systems, and EPA approval has been granted for destruction of in-house PCB wastes as an alternative to off-site disposal. The EPA permits apply only to the destruction of in-house wastes and the companies cannot accept wastes from other sources; therefore the incinerators cannot be considered commercial.

TABLE 2 SUMMARY EVALUATION: THERMAL PCB DESTRUCTION TECHNOLOGIES

PCB Destruction Technologies	Commercial	Near-Commercial	Promising/ Developing
Stationary	- Ensco Environmental Services - Hessian Industrial Waste Inc. (HIM) - Kommunekemi - Pyrochem - ReChem International (IEM Corp.) - Rollins Environmental Services - SAKAB - SCA Chemical Services	- Alberta Special Waste Management Corp.* - Arc Technologies Co. - Selenco/Sanivan Group*	- Ontario Waste Management Corp.*
Mobile/ Transportable		- Ensco Environmental Services MWP2000 - Haztech, Inc.* - IT Corp. - Ogden Environmental Services, Inc. - O.H. Materials, Inc.* - Riedel Environmental Services* - Selenco/Sanivan Group* - Shirco Infrared Systems, Inc.	- Vesta Technology Ltd. - Westinghouse Electric Corp.
Incineration at Sea		- Chemical Waste Management, Inc.	

* Organizations that propose to operate PCB destruction technologies designed and constructed by others. These organizations are not proponents or developers of specific technologies.

Seven of the destruction systems utilize liquid injection incinerators and one system uses a standard aluminum melting furnace. None of the liquid injection units was originally designed for PCB destruction and all have been modified as required. Generally, companies would not divulge operating details or information about waste quantities treated, although the quantity of in-house PCB-contaminated oil (350 ppm

average PCB concentration) at one location was 6.06 million litres. At least two of the companies reported that they now ship all in-house PCB wastes off-site for disposal at Rollins Environmental Services or Ensco, in lieu of treatment in their in-house facilities.

In the U.S., eighteen high-efficiency boilers are permitted to destroy PCB wastes in conjunction with the firing of coal or oil/gas fuels. Since these boilers are for in-house use only and do not operate commercially, they were not included in the technologies surveyed.

3.2.3 Mobile/Transportable PCB Destruction. A number of companies have developed mobile/ transportable PCB thermal destruction systems. These mobile/transportable systems have the advantage that destruction can be performed on-site, which eliminates the costs and risks of transporting wastes from a waste site to a stationary destruction facility. Few systems are truly mobile in that the system or system modules can travel by road to the site and be operative with no additional site assembling or fabrication. In general, the size and complexity of thermal destruction systems requires site preparation, system module assembly, and a commissioning trial burn period prior to hazardous waste operation.

Companies with rotary kiln systems are Ensco Environmental Services, IT Corporation, Vesta Technology Ltd. and Roy F. Weston, Inc. Companies with alternative thermal destruction systems are Riedel Environmental Services, O.H. Materials, Inc., Haztech, Inc., Shirco Infrared Systems, Inc., Ogden Environmental Services, and Westinghouse Electric Corp.

Ensco Environmental Services has three transportable, commercial organic waste destruction units which were designed to accept PCBs. The MWP2000 system is a transportable, rotary kiln system which can accept liquid and solid wastes including soils and shredded electrical capacitors (Table A-19). The rotary kiln unit comprises six trailer modules and requires four to six weeks for site set-up and shakedown. A destruction and removal efficiency of greater than 99.9999% has been demonstrated with trichlorobenzene and PCB wastes. Expected destruction costs are in the range of $350 to $1000 U.S./tonne. A minimum job size for MWP2000 unit of 2300 cubic metres is suggested. The MWP2000 system has been used since 1984 to destroy chlorinated organics in wastewater, sludges and soils at a contaminated waste lagoon site in Florida. EPA trial burns with the MWP2000 system were conducted with PCB wastes and dioxin-contaminated solid wastes in 1986 and 1987 under the Toxic Substances Control Act (TSCA). This mobile rotary kiln system is considered near-commercial because it is

currently in the regulatory permit stage of development; final approval was anticipated by late 1987. The Selenco/Sanivan Group are proposing to use the MWP2000 system in Canada.

Ensco Environmental Services has also two liquid injection systems. The MWP75 system has EPA permits for commercial liquid PCB destruction in six EPA regions. This system is transportable, but has been operated only at Ensco's stationary facility (Eldorado, Arkansas) because economics have favoured transport of liquid wastes to the site, rather than transporting the unit to the wastes. The MWP100 system is a second generation liquid injection unit based on the design and experience with the MWP75. The MWP100 system demonstrated the required PCB destruction efficiency in 1984 EPA trial burns. However, EPA certification requires additional test burns to monitor dioxin and furan emission levels, and these tests are not planned. Ensco Environmental Services do not intend to develop these liquid injection units further, since they are developing the MWP2000 rotary kiln system. Based on their development and regulatory status, the MWP75 and MWP100 could be evaluated as commercial and near-commercial technologies; however, they were not evaluated further because Ensco Environmental Services does not offer these technologies commercially for transportable PCB destruction.

IT Corporation of Knoxville, Tennessee, is developing a transportable rotary kiln system for PCB waste destruction (Table A-21). A permit application has been submitted for TSCA approval and trial burns were scheduled for October 1987. This rotary kiln unit is capable of handling 20000 kilograms/hour of contaminated soil. This technology is considered near-commercial.

Roy F. Weston, Inc., of West Chester, Pennsylvania, is developing a rotary kiln system for remediation of an Illinois waste site containing PCB-contaminated soil. This destruction system is specific to the Illinois site remediation program and Roy F. Weston, Inc., will not offer the system in Canada.

Vesta Technology Ltd. of Florida has developed a mobile rotary kiln system (Table A-27) which is on one flat bed trailer and requires only minimal time to set up on-site (24 hours). To date this system has operated only on non-PCB wastes. This system was designed to also handle PCB wastes. Vesta was planning to conduct trial burns on PCB wastes for Quebec Hydro during the summer of 1988. This technology is considered promising.

Riedel Environmental Services, O.H. Materials Inc. and Haztech, Inc. all intend to employ the Shirco technology. Shirco Infrared Systems Inc. has pilot-scale and

full-scale transportable infrared energy systems to thermally destroy PCB-contaminated soils (Table A-25). Both the pilot-scale and the full-scale units have operated at Superfund sites for the destruction of hazardous organic wastes. As part of a TSCA permit submission by Shirco, trial burns were conducted in 1986. Trial burns with the pilot-scale unit achieved greater than 99.9999% destruction and removal efficiency on PCB-contaminated soil. Riedel Environmental Services (Table A-24), O.H. Materials (Table A-23) and Haztech, Inc. (Table A-20) have submitted TSCA permit applications. The Shirco System is considered near-commercial. O.H. Materials have a Canadian office in Oakville, Ontario and have proposed to use the Shirco system for the remediation of a PCB waste site in Ontario.

Ogden Environmental Services Inc. has developed a circulating bed technology for the destruction of organic hazardous wastes including PCBs (Table A-22). Ogden acquired the circulating bed combustion technology of GA Technologies Inc. and offer both stationary and transportable systems of various capacities. The technology received a TSCA permit in early 1987, to handle soil containing up to 10 000 ppm PCBs. Although the technology has regulatory approval it was still considered near-commercial because it had not operated commercially for one year. In Canada, Ogden Environmental Services is marketing this technology through their associate Toronto company, Ogden Allied Canada.

The mobile plasma arc technology of Westinghouse Electric Corp. has been tested at pilot and full-scale with PCB liquid wastes (Table A-28). This technology is considered promising.

The EPA Office of Research and Development (ORD) operates a full-scale, transportable rotary kiln system which is used to demonstrate the capability of this technology to destroy a variety of hazardous wastes. The unit is capable of handling PCB liquids, sludges and solids including soils and capacitors, but has only been tested on PCB liquid wastes. The transportable unit comprises four trailer modules. A trial burn on 40% by weight feed of askarel demonstrated a destruction and removal efficiency of 99.99991%. Estimated commercial destruction costs are in the range of $250-1100 U.S. per tonne. Since the system is operated by private companies under contract to the EPA and will not be accepting commercial waste for destruction, it was not evaluated further.

The J.M. Huber Corporation advanced electric reactor has been proven at the pilot scale, and is permitted in various EPA regions and states, but the company has decided not to pursue application to hazardous wastes in the future. The Rockwell International Energy Systems molten salt combustor has also been tested at pilot-scale

and has a research permit for PCB burns. Rockwell does not intend to provide waste treatment services.

A summary of the evaluation of mobile/transportable thermal PCB destruction technologies is presented in Table 2.

In addition to these mobile/transportable destruction technologies, others were surveyed but not evaluated. The development status and company backgrounds of these technologies varied considerably. The companies range from relatively new, small companies to well-established international corporations. In some cases, the application of new or existing thermal technologies to PCB destruction has been proposed in concept only and operating systems have not been constructed. In other cases, operating pilot-scale systems are well-developed and have been demonstrated on a limited scale for PCB destruction. Although many of the systems show promise technically as future commercial means of PCB destruction, it is not known what the future development status is and whether it could be applied to commercial PCB destruction of Canadian wastes within less than two years.

3.2.4 At-Sea Incineration. In addition to land-based facilities for the destruction of PCBs, one U.S. company (Chemical Waste Management Inc.) has incineration-at-sea vessels.

In addition to Chemical Waste Management, Inc. of the United States two additional incinerator ships, the Vesta owned by Lehnkering Montan Transport A.G. of West Germany and the Matthias II owned by Incimer, Inc., undertake commercial hazardous waste destruction in Europe.

At-Sea-Incineration, Inc., of Elizabeth, N.J., built two vessels for the incineration of liquid hazardous wastes, including PCBs, but neither of the ships underwent EPA performance testing. These ships were not evaluated further because At-Sea-Incineration, Inc. recently filed for bankruptcy.

Chemical Waste Management, Inc. owns and operates the Vulcanus I and II which use vertical liquid injection incinerators (Table A-29). The Vulcanus I has operated commercially in Europe and has undergone a series of hazardous waste incineration tests that date back to 1974. The Vulcanus I PCB test burns sanctioned by the U.S. EPA were undertaken in late 1981 and August 1982. The Vulcanus II, launched in 1982, has three incinerators at the stern. It has not undergone a U.S. EPA PCB test burn program to date, but has operated commercially in Europe. The Vulcanus I and II vessels are considered near-commercial.

Environmental Oceanic Services of Seattle, Washington, proposed leasing a ship and mounting an incinerator in association with 16 containers on deck. Seaburn Inc. of Greenwich, Connecticut, proposed to utilize an ocean-going barge equipped with an incinerator and bulk containers to dispose of liquid hazardous waste. Further development by these two companies has not proceeded as a final decision by the EPA on the permitting of hazardous waste incineration at sea is pending.

United States regulations governing the destruction of hazardous wastes using incineration-at-sea vessels are under review. Initial evaluation of the test burn data from the Vulcanus I indicated that the destruction efficiencies required for incinerating chlorinated organics, including PCBs, were achieved. However, the testing protocols used and validity of results have since been questioned by a number of organizations and this has caused the EPA to re-evaluate its policy regarding incineration-at-sea.

In Canada, the incineration of hazardous wastes at sea is governed by the Canadian Environmental Protection Act. Canada is also a signatory to the 1972 London Dumping Convention. Under this agreement, member countries have adopted uniform regulations for the incineration of hazardous wastes at sea.

3.2.5 Mobile Oil Treatment Processes. Chemical processes for the decontamination of PCB-contaminated oil are regarded as proven technologies. The most common chemical destruction method is based on the use of sodium which reacts selectively with the chlorine in the PCB molecule to produce sodium chloride and non-halogenated polyphenyl. In most commercial systems, the products of this reaction are readily separated to permit the base oil to be recycled or re-used. The principal commercial application of the process is the removal of PCBs from PCB-contaminated mineral oil. Other chemical destruction methodologies have been developed, and three companies have proceeded to the near-commercial stage in developing non-sodium chemical destruction processes.

A review of information from companies using chemical PCB-destruction technologies indicates several general conclusions:

- Full-scale, sodium-based processes have been successfully used commercially since 1979 in the United States. The sodium-based processes can be classed as proven technology.
- Chemical methods have been successfully applied to treat oils in energized transformers.

The following companies offer commercial mobile services:

Chemical Decontamination Corp.,
Chemical Waste Management, Inc.,
Excel Tech Inc.,
PPM Canada Inc.,
Rondar, Inc.,
Selenco/Sanivan Group,
Sun Environmental Ltd., and
Transformer Consultants.

All of the above companies offer full-scale commercial operations. Two additional companies, PCB Eliminators and Trinity Chemical, operate stationary PCB dechlorination units. In Canada, PPM Canada Inc. (Table A-36) has performed commercial PCB dechlorination in Nova Scotia, New Brunswick, Quebec, Ontario, Saskatchewan and British Columbia. PPM Canada Inc. is also operating one of its mobile units in the stationary mode in Saskatchewan. Sun Environmental, formerly Sunohio (Table A-39), has provided commercial services in Manitoba, Ontario, Quebec and Prince Edward Island.

Rondar Inc. is a Canadian company which operates commercially Ontario Hydro's mobile oil treatment process (Table A-37). Rondar has provided commercial services in Nova Scotia, Quebec and Ontario.

The Selenco/Sanivan Group of Burlington, Ontario has two mobile dechlorination units. These units, which utilize the Transformer Consultants Inc. process, have operated commercially in Quebec (Table A-38). A permit application to operate in Ontario has been submitted to the Ontario Ministry of the Environment for approval.

Mobile PCB decontamination technologies can be used to treat contaminated oils with maximum PCB concentrations from 7000 to 20 000 ppm. Contaminated oil feed rates vary by process type and concentration of PCBs in the contaminated oil. Typical feed rates range from 700 to 3000 litres per hour. These mobile technologies consist of one or two trailer modules and require less than three days of set-up time. Treatment costs depend upon the volume of oil to be processed, the concentration of PCBs in the oil, and the site location. General costs range from $0.50 to $5.50 per litre of oil treated. Construction costs, excluding development costs, are reported to range from $400 000 to $700 000 U.S. Wastes generated are reaction by-product sludges, cartridge filters, and rags and cloths. The treatment and disposal of liquid and solid residues generated by these dechlorination processes is the responsibility of the operator of the process.

Concentrations of PCBs and other contaminants are monitored and the solid residues disposed of in accordance with local regulations.

Three companies are developing non-sodium based processes. General Electric is developing a mobile oil treatment system based on a PEG/KOH (poly(ethylene glycols)/potassium hydroxide) process (Table A-33). General Electric has an EPA research and development permit to test the unit and have submitted an application for commercial operation. In addition to offering the service in the United States, they will also offer it in Canada through Canadian General Electric, Burlington. This technology is considered near-commercial.

IT Corporation of Torrance, California, has purchased the Niagara Mohawk Power PEG/KOH technology and has applied for a commercial TSCA permit. They also intend to offer this service in Canada. This technology is considered near-commercial.

Ozonics Technology Inc. of Closter, N.J., is developing a mobile oil treatment process that uses a combination of ozone, ultra-violet light and ultrasonics to decontaminate PCB-contaminated oils (Table A-35). An application has been submitted for commerical operation; therefore the technology is considered near-commercial.

A summary of the evaluation of chemical oil treatment processes is presented in Table 3.

TABLE 3 SUMMARY EVALUATION: CHEMICAL PCB DESTRUCTION TECHNOLOGIES

PCB Destruction Technologies	Commercial	Near-Commercial	Promising/ Developing
Stationary Oil Treatment	- PCB Eliminators - PPM Canada, Inc. - Trinity Chemical Co.		
Mobile Oil Treatment	- Chemical Decontamination Corp. - Chemical Waste Management Inc. - Excel Tech Inc. - PPM Canada, Inc. - Rondar, Inc. - Selenco/Sanivan Group - Sun Environmental Ltd. - Transformer Consultants	- General Electric Co. - IT Corp. - Ozonics Technologies, Inc.	

3.2.6 Alternative PCB Solid Waste Treatment. Currently various technologies are available to treat and destroy the range of PCB wastes. These have been identified and evaluated in previous sections. In addition to the thermal technologies available to handle PCB-contaminated solids, research and development is underway on alternative methods of managing and destroying PCB solid wastes. The U.S. EPA has evaluated six potentially applicable technologies for the treatment of PCB-contaminated sediments[14]: low-temperature oxidation; chlorine removal; pyrolysis; extraction and concentrating; vitrification; and biodegradation. The solvent extraction processes of Acurex, O.H. Materials Inc. and Oak Ridge Laboratory, and the pyrolysis process of of J.M. Huber Corp. were considered potential candidates by the U.S. EPA.

The low-temperature (supercritical water) oxidation process of Modar Inc. (Table A-46) was considered a candidate for potential application by the EPA and can be considered a promising technology.

The chlorine removal process of Galson Research Corporation (Terraclean-Cl) (Table A-45) was also considered a candidate by the EPA and is considered promising technology.

An in-situ vitrification process developed by Battelle Pacific Northwest Laboratory (Table A-42) for the U.S. Department of Energy has demonstrated the capability of treating PCB-contaminated soils in a pilot test.[15] The U.S. Environmental Protection Agency is considering the use of this technology to vitrify sludge contaminated with PCBs.[15] Vitrification process technology can be considered promising.

Two companies are actively developing biodegradation processes for the treatment of soils contaminated with hazardous wastes including PCBs. Detox Industries Inc. of Stafford, Texas, have been granted a commercial permit (Table A-44). Bioclear Corporation of Houston, Texas, have applied for a research and development TSCA permit. They intend to develop a commercial transportable PCB destruction technology (Table A-43). The Detox process is considered commercial and the Bioclear process is considered promising.

In addition, SRH Associates Inc. are developing a thermal system to extract PCBs from contaminated sludges and soils (Table A-49). A fluidized bed is used to vapourize organic material including PCBs. The vapours are then condensed and collected. This process is at the developmental stage and is considered promising.

A summary of the evaluation of these alternative PCB solid waste treatment technologies is presented in Table 4.

TABLE 4 SUMMARY EVALUATION: ALTERNATIVE PCB SOLID WASTE TREATMENT TECHNOLOGIES

PCB Treatment Technologies	Commercial	Near-Commercial	Promising/Developing
Biodegradation	- Detox Industries, Inc.		- Bioclear Corp.
Chlorine Removal			- Galson Research Corp.
Low Temperature Oxidation			- Modar, Inc.
Solvent Extraction			- Acurex - O.H. Materials, Inc.
Thermal Extraction			- SRH Associates, Inc.
Vitrification			- Battelle Pacific Northwest Laboratory

4 CONCLUSIONS

Based on this evaluation of PCB destruction technologies, rotary kiln incineration with flue-gas treatment is preferred for commercial stationary PCB destruction. This technology is capable of handling not only PCB wastes but other industrial organic hazardous wastes. Companies in Europe and United States that utilize rotary kilns successfully operate regional or national hazardous waste treatment facilities. The Alberta Special Waste Management Corporation, the Ontario Waste Management Corporation, and Selenco/Sanivan Group are developing hazardous waste treatment facilities. The Alberta facility opened in Swan Hills in 1988, while facilities are expected to be commercially operational in Quebec in 1990 and in Ontario in 1991. IEM Corp. of Edmonton provides a service that ships PCB wastes to Great Britain for destruction.

Eight North American companies have near-commercial mobile/transportable destruction technologies. Three companies, Ogden Environmental Services, O.H. Materials Inc. and the Selenco/Sanivan Group have Canadian representation.

Of the eight commercial, mobile oil treatment technologies, four are operating in Canada; these are Sun Environmental, PPM Canada, Inc., Rondar Inc. and the Selenco/Sanivan Group. In addition, two companies, IT Corp. and General Electric Co., have near-commercial technologies which they intend to offer in Canada. These oil treatment technologies are proven; four are immediately available in Canada and are capable of destroying PCBs in PCB-contaminated oil. It may be noted that PCB-contaminated oil represents a large portion by volume of PCB wastes in Canada.

Solvent extraction technology is being developed by six American companies for application to PCB-contaminated soils and is considered a promising technology. The alternative technologies of low-temperature oxidation, chlorine removal, vitrification, thermal extraction and biodegradation are also being developed for the treatment of PCB solid wastes and are considered promising technologies.

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APPENDIX

APPENDIX

PCB DESTRUCTION TECHNOLOGY DATA SHEETS

This appendix contains technical information in summary form and on detailed data sheets. Only technologies for which there was sufficient relevant information available and which were evaluated as commercial, near-commercial or promising are presented in the detailed data sheets.

APPENDIX - CONTENTS

	Table
Summary Data Sheets	
Summary of Stationary PCB Destruction Technologies	A-1
Summary of In-house, Stationary PCB Destruction Technologies	A-2
Summary of Mobile/Transportable PCB Destruction Technologies	A-3
Summary of Incineration-at-Sea Technologies	A-4
Summary of PCB-Contaminated Oil Treatment Processes	A-5
Summary of Alternative PCB Solid Waste Treatment Technologies	A-6
Detailed Data Sheets	
Stationary, PCB Destruction Technologies	
Alberta Special Waste Management Corp.	A-7
Arc Technologies	A-8
Ensco Environmental Services	A-9
Hessian Industrial Waste Inc.	A-10
Kommunikemi	A-11
Ontario Waste Management Corp.	A-12
Pyrochem	A-13
Rollins Environmental Services	A-14
ReChem International Ltd. (IEM Corp.)	A-15
SAKAB	A-16
Selenco/Sanivan Group	A-17
SCA Chemical Services	A-18
Mobile/Transportable PCB Destruction Technologies	
Ensco Environmental Services MWP2000	A-19
Haztech Inc.	A-20
IT Corp.	A-21
Ogden Environmental Services Inc.	A-22
O.H. Materials, Inc.	A-23
Riedel Environmental Services	A-24
Shirco Infrared Systems, Inc.	A-25

Selenco/Sanivan Group	A-26
Vesta Technology Ltd.	A-27
Westinghouse Plasma Systems	A-28
Incineration-at-sea	
Chemical Waste Management Inc.	A-29
Mobile Oil Treatment	
Chemical Decontamination Corp.	A-30
Chemical Waste Management Inc.	A-31
Excel Tech Inc.	A-32
General Electric Co.	A-33
IT Corp.	A-34
Ozonics Technology Inc.	A-35
PPM Canada, Inc.	A-36
Rondar Inc.	A-37
Selenco/Sanivan Group	A-38
Sun Environmental Ltd.	A-39
Transformer Consultants	A-40
Alternative PCB Solid Waste Treatment Technologies	
Acurex	A-41
Battelle Pacific Northwest Laboratory	A-42
Bioclear Corp.	A-43
Detox Industries, Inc.	A-44
Galson Research Corporation	A-45
Modar Inc.	A-46
O.H. Materials Inc.	A-47
Oak Ridge National Laboratory	A-48
SRH Associates, Inc.	A-49

TABLE A-1 : SUMMARY OF STATIONARY PCB DESTRUCTION TECHNOLOGIES

Technology Identification	Development Status	Approval Status (PCB Destruction)	PCB Wastes Accepted			Availability in Canada
			Type	Feedrate	Full-scale operation with this waste type	
ALBERTA SPECIAL WASTE MANAGEMENT CORP. Rocking Kilns	Commercial hazardous waste treatment including destruction of all forms of PCB wastes.	Trial testing in 1988	Liquids Sludges Soils Solids	Total wastes 1.5 t/h	None	Commercial destruction of Alberta PCB wastes in 1988.
ARC TECHNOLOGIES Pyrolitic DC Arc Furnace	System is built and is undergoing EPA trial burns for a commercial permit.	Commercial EPA* permit is pending	PCB capa-citors	12 t/h	None	Not accessibile due to border closure to PCB wastes
ENSCO ENVIRONMENTAL SERVICES Rotary Kiln	Commercial hazardous waste treatment includung destruction of all forms of PCB wastes.	Commercial EPA permit	Liquids Sludges Soils Solids	8.1 t/h	Commercial destruction of PCB wastes since 1981.	Not accessibile due to border closure to PCB wastes
HESSIAN INDUSTRIAL WASTE, INC. (HIM) Rotary Kiln	Commercial hazardous waste treatment includung destruction of all forms of PCB wastes.	West German permits	Liquids Sludges Soils Solids	2.8 t/h	Commercial destruction of PCB wastes since 1982.	Accepts only West German wastes
KOMMUNEKEMI Rotary Kilns	Commercial hazardous waste treatment includung destruction of all forms of PCB wastes.	Danish permits	Liquids Sludges Soils Solids	Total wastes 9.0 t/h	Commercial destruction of PCB wastes since 1975.	Accepts only Danish wastes
ONTARIO WASTE MANAGEMENT CORP. Rotary Kiln	A hazardous waste treatment facility is in the planning stage. Commercial operation is anticipated for 1991.	No permit applications submitted	Liquids Sludges Soils Solids	9.6 t/h	None	Commercial operation for 1991

* EPA = U.S. Environmental Protection Agency

TABLE A-1 (CONT'D) : SUMMARY OF STATIONARY PCB DESTRUCTION TECHNOLOGIES

Technology Identification	Development Status	Approval Status (PCB Destruction)	PCB Wastes Accepted			Availability in Canada
			Type	Feedrate	Full-scale operation with this waste type	
PYROCHEM Rotary kiln	Commercial treatment of hazardous wastes including PCB wastes.	Commercial EPA permit	Liquids Solids Sludge Soil	Not specified	Continuous since 1986.	Not accessible due to border closure to PCB wastes.
ROLLINS ENVIRONMENTAL SERVICES Rotary kiln	Commercial treatment of hazardous wastes including PCB wastes.	Commercial EPA permit	Liquids Solids Sludge Soil	22.3 t/h	Continuous since 1981.	Not accessible due to border closure to PCB wastes.
SAKAB Rotary kiln	Commercial treatment of hazardous wastes including PCB wastes.	Swedish permit	Liquids Solids Sludge Soil	5.0 t/h	Continuous since 1983.	Accepts only Swedish wastes.
SELENCO/SANIVAN GROUP Rotary kiln	A hazardous waste treatment plant is currently at the design stage. An Ensco/Pyrotech MWP2000 is proposed for Senneterre, P.Q.	No destruction permits.	Liquids Solids Sludge Soil	4.0 t/h	None	Anticipated start of commercial operation is 1990.
SCA CHEMICAL SERVICES - Rotary kiln	Commercial treatment of hazardous wastes including PCB wastes.	Commercial EPA permit	Liquids Solids Sludge Soil	1.3 t/h	Continuous since 1983.	Not accessible due to border closure to PCB wastes.

TABLE A-2 : SUMMARY OF IN-HOUSE PCB DESTRUCTION TECHNOLOGIES

Technology Identification	Development Status	Approval Status (PCB Destruction)	PCB Wastes Accepted			Availability in Canada
			Type	Feedrate	Full-scale operation with this waste type	
ALUMINIUM CO. OF AMERICA Aluminum melting furnace	A standard melting furnace was equipped with contrals for destruction of PCB-contaminated oil.	EPA permit for PCB in oil.	Liquids	0.261 kg/h	EPA trial burns of 930 000 litres of PCB oil (350 ppm avg PCB) from 1982 to 1984.	Not available for commercial wastes.
DOW CHEMICAL CO. Liquid injection incinerators	Dow operates two liquid injection incinerators for the disposal of chemical production wastes at plant in Freeport, Texas.	EPA permit for in-house PCB liquids.	Liquids	Not specified	In operation since 1981.	Not available for commercial wastes.
GENERAL ELECTRIC CO. Liquid injection incinerators	GE operates two liquid injection incinerators originally designed for waste oils and solvents. PCB-contaminated oils are destroyed.	EPA permit for in-house PCB liquids.	Liquids	Not specified	In operation since 1981.	Not available for commercial wastes.
LA PORTE CHEMICAL CORP. Liquid injection incinerators	La Porte operates a chemical and solvent waste incinerator to destroy in-house liquid PCB wastes.	EPA permit for in-house PCB liquids.	Liquids	1200 L/h	Not specified	Not available for commercial wastes.
TENNESSEE EASTMAN Liquid injection incinerator	Eastman operates a liquid injection incinerator for the destruction of in-house wastes.	EPA permit for in-house PCB wastes.	Not specified.	Not specified	Not specified	Not available for commercial wastes.
VULCAN MATERIALS CO. Liquid injection incinerator	Vulcan operates an incinerator for the destruction of in-house wastes. The system is a modified John Zink incinerator.	EPA permit for in-house PCB liquids.	Liquids	Not specified	Not specified	Not available for commercial wastes.

TABLE A-3 : SUMMARY OF MOBILE/TRANSPORTABLE PCB DESTRUCTION TECHNOLOGIES

Technology Identification	Development Status	Approval Status (PCB Destruction)	PCB Wastes Accepted			Availability in Canada
			Type	Feedrate	Full-scale operation with this waste type	
ENSCO/PYROTECH MWP2000 Rotary kiln	The incinerator system has been in commercial operation for non-PCB wastes since 1984.	Commercial PCB permit pending from EPA	Liquids Solids Sludge Soil	4.0 t/h	None	Currently no Canadian representation.
HAZTECH INC. Shirco Infrared	The infrared system has operated commercially on non-PCB wastes since 1986.	Commercial PCB permit pending from EPA	Sludge Soil	4.5 t/h	None	Currently no Canadian representation.
IT CORP. Rotary kiln	The rotary kiln system has been in commercial operation on non-PCB wastes since 1986.	Commercial PCB permit pending from EPA	Liquids Solids Sludge Soil	Not specified	None	Currently no Canadian representation.
OGDEN ENVIRONMENTAL SERVICES Circulating bed combustion (CBC)	Ogden purchased CBC technology from GA Technologies. Hazrardous and PCB wastes have been destroyed in apilot plant.	EPA permit for PCBs in soils.	Liquids Solids Sludge Soil	Not specified	None	Available from Ogden Allied Services, Toronto
O.H. MATERIALS, INC. Shirco Infrared	The infrared system has operated commercially on non-PCB wastes since 1987.	Commercial PCB permit pending from EPA	Soil Sludge	4.5 t/h	None	Available from OH Materials, Burlington, Ont.
RIEDEL ENVIRONMENTAL TECHNOLOGIES Shirco Infrared	Riedel received delivery of infrared system in 1987.	Commercial PCB permit pending from EPA	Soil Sludge	4.5 t/h	None	Currently no Canadian representation.

TABLE A-3 (CONT'D) : SUMMARY OF MOBILE/TRANSPORTABLE PCB DESTRUCTION TECHNOLOGIES

Technology Identification	Development Status	Approval Status (PCB Destruction)	PCB Wastes Accepted			Availability in Canada
			Type	Feedrate	Full-scale operation with this waste type	
SHIRCO INFRARED SYSTEMS, INC. Infrared Energy	Pilot and full-scale systems have demonstrated destruction of PCB-contaminated soils. Systems delivered to Haztech, OHM and Riedel.	EPA permit for research and development	Solids Sludges Soils	1.0 to 10.0 t/h	None	Systems are available for lease or purchase.
SELENCO/SANIVAN GROUP Ensco/Pyrotech MWP2000	An MWP2000 is proposed for a PCB waste site in Ontario.	Permit submitted to MOE	Liquids Solids Sludges Soils	Approx. 1600 kg/h total	None	Available from Selenco/Sanivan, Oakville, Ont.
VESTA Rotary Kiln	A mobile rotary kiln system has commercvially destroyed non-PCB hazardous waste.	No PCB permit	Liquids Solids Sludges Soils		None	Currently no Canadian representation
WESTINGHOUSE PLASMA SYSTEMS Plasma Arc	Prototype and full-scale tests have been tested on PCB liquid wastes. Further teste are planned.	No PCB permit	Liquids	720 kg/h	None	Currently no Canadian representation

TABLE A-4 : SUMMARY OF INCINERATION-AT-SEA TECHNOLOGIES

Technology Identification	Development Status	Approval Status (PCB Destruction)	PCB Wastes Accepted			Availability in Canada
			Type	Feedrate	Full-scale operation with this waste type	
CHEMICAL WASTE MANAGEMENT, INC. Incineration vessels	Vulcanus I has under gone EPA and European tests and has operated commercially from Europe. Vulcanus III has also operated commercially in Europe.	European permits	Liquids	18700 L/h	Commercial operation in Europe since 1982.	Currently no Canadian representation

TABLE A-5 : SUMMARY OF PCB-CONTAMINATED OIL TREATMENT PROCESS

Technology Identification	Development Status	Approval Status (PCB Destruction)	PCB Wastes Accepted			Availability in Canada
			Type	Feedrate	Full-scale operation with this waste type	
CHEMICAL DECONTAMINATION CORP. Sodium Process	In commercial operation in the U.S. since 1979.	Commercial EPA permit	PCB in oil	Batch 9000 L	In U.S. commercial operation since 1979.	Currently no Canadian representation
CHEMICAL WASTE MANAGEMENT INC. Sodium Process	CWM purchased the Acurex process in 1985. CWM has operated the process commercially in the U.S. since 1986.	Commercial EPA permit	PCB in oil to 10000 ppm	Batch 8600 L.	In U.S. commercial operation since 1986.	Currently no Canadian representation
EXCEL TECH Sodium Process	In commercial operation in the U.S. since 1983.	Commercial EPA permit	PCB in oil to 7000 ppm	Batch, not specified	In U.S. commercial operation since 1983.	Currently no Canadian representation
GENERAL ELECTRIC PEG/KOH	Prototype and full-scale units are being developed for commercial use.	Commercial EPA permit pending	PCB in oil to 20000 ppm	Batch (27000L) or continous	None	Currently not available. When developed, from CGE.
IT CORP. PEG/KOH/DMSO	IT Corp purchased the Niagara Mohawk process in 1987.	Commercial EPA permit pending	PCB in oil	Batch, not specified	None	Currently not available commercially
OZONICS TECHNOLOGY INC. Ozone/UV/Ultrasonics	Prototype unit is being developed for commercial use.	Commercial EPA permit pending	PCB in oil	Not specified	None	Currently not available commercially

TABLE A-5 (CONT'D) : SUMMARY OF PCB-CONTAMINATED OIL TREATMENT TECHNOLOGIES

Technology Identification	Development Status	Approval Status (PCB Destruction)	PCB Wastes Accepted			Availability in Canada
			Type	Feedrate	Full-scale operation with this waste type	
PPM CANADA INC. Sodium process	In commercial operation since 1981in the United States..	Permitted in 7 Canadian provinces	PCB in oil to 20 000 ppm	Batch (4500 L)	In Canada since 1983	The service is currently available in Canada.
RONDAR INC. Sodium process	Developed jointly by Ontario Hydro and BC Hydro for in-house use. Licensed by Rondar for commercial use. First operated in1986.	Permited in N.S., P.Q. and Ont.	PCB in oil to 7000 ppm	Batch, 6000 L	In commercial operation in Nova Scotia and Quebec since 1986, in Ontario since 1987.	The service is currently available in Canada.
SELENCO/SANIVAN GROUP PEG/KOH	Process has been in operation in the U.S. since 1982. It has operated commercially in Quebec since1986.	P.Q. permit, Ont pending	PCB in oil to 3300 ppm	Max. of 6500 L/h	In commercial operation in US since 1982, in Canada since 1986.	The service is currently available in Canada.
SUNOHIO CANADA INC Sodium process	In commercial operation in the U.S. since 1981.	All provinces except Alberta	PCB in oil to 10 000 ppm	Batch 22 400 L or continuous	In commercial operation in Canada since 1984.	The service is currently available in Canada.
TRANFORMER CONSULTANTS INC. PEG/KOH	In commercial operation in the U.S. since 1982.	Commercial EPA permit	PCB in oil to 20 000 ppm	8600 L	In commercial operation in the U.S. since 1982.	Currently no Canadian representation.

TABLE A-6 : SUMMARY OF ALTERNATIVE PCB SOLID WASTE TREATMENT TECHNOLOGIES

Technology Identification	Development Status	Approval Status (PCB Destruction)	PCB Wastes Accepted			Availability in Canada
			Type	Feedrate	Full-scale operation with this waste type	
ACUREX WASTE TECHNOLOGIES Freon/Hexane Mobile	Successful pilot scale tests conducted in 1985. Status of proposed full-scale system unknown.	Research & development permit	PCB in soil to 2000 ppm	Batch, not specified	None	Not available in Canada
BATTELLE PACIFIC NORTHWEST LABS Vitrification Transportable	Technology is in the prototype stage of development. Pilot-scale tests were successfully performed. Further tests are planned.	None	PCB in soil	Not applicable	None	Not available in Canada
BIOCLEAR CORP. Biodegradation Transportable	Technology is in the prototye stage of development. Commercial development is planned.	Research & development permit pending	PCB in soil & sludges	Batch	None	Not available in Canada
DETOX INDUSTRIES Biodegradation Transportable	Technology is commercial. Process has treated PCP-creosote wastes and PCB-contaminated sediments.	Commercial EPA permit	PCB in soil & sludges	Batch	In commercial operation in the U.S. since 1986	Not available in Canada
GALSON RESEARCH Chlorine Removal Mobile	Technology is in the prototype stage of development. Status of future development is unknown.	None	PCB in soil & sludges	Batch	None	Not available in Canada
MODAR INC. Supercritical Water Transportable	Technology is in the prototype stage of development. Commercial development is planned.	None	PCB in soil & sludges	Batch	None	Not available in Canada

TABLE A-6 (CONT'D) : SUMMARY OF ALTERNATIVE PCB SOLID WASTE TREATMENT TECHNOLOGIES

Technology Identification	Development Status	Approval Status (PCB Destruction)	PCB Wastes Accepted			Availability in Canada
			Type	Feedrate	Full-scale operation with this waste type	
OH MATERIALS Methanol Extraction Transportable	Field tested in 1986. Status of future development unknown.	Research & development permit	PCB in soil	Not applicable	None	Not available in Canada
OAK RIDGE NATIONAL LABS Soilex Extraction Transportable	Pilot-scale tests conducted in 1984. Status of future development unknown.	None	PCB in soil	Not applicable	None	Not available in Canada
SRH ASSOCIATES Fluidized Bed Transportable	A system has been constructed to treat PCB wastes. Trial burns were planned for late 1987.	None	Solids Soils Sludges	Not specified	None	Not available in Canada

TABLE A-7 : ALBERTA SPECIAL WASTE MANAGEMENT CORP. IDENTITY AND STATUS

Company Name ALBERTA SPECIAL WASTE MANAGEMENT CORP. (ASWMC)	**Technology Name** ASWMC Incinerators **Technology Type** Von Roll Rocking Kiln	
Address c/o Chem-Security Ltd. 1323 44th Ave. NE Calgary, Alberta T2E 6L5	**Operating Site** Swan Hills, Alberta	**Contact** John Richardson (403) 250-3742
Process Overview The ASWMC hazardous waste incinerator system includes : i) two Von Roll rocking kilns each capable of handling wastes in 200 litre drums, ii) two secondary combustion chambers for the two rocking kilns, iii) a common pollution control system for both of the rocking kilns which is a quench tower, a venturi scrubber, and a three stage ionic wet scrubber system. A two kiln system was selected to permit flexibility of operation needed when handling the large variety of waste types and quantities anticipated.	**Development Status** The facility has been constructed and will be operated by Chem-Security Ltd. for ASWMC. Compliance testing for approval is scheduled for 1988.	
Approval Status Incinerator system has recieved an permit from Alberta Department of the Environment for trial burns.	**Availability Status** Start of commercial operation is anticipated in 1988.	

TABLE A-8 ARC TECHNOLOGIES : IDENTITY AND STATUS

Company Name Arc Technologies Co.	**Technology Name** Arc Furnace **Technology Type** Pyrolytic DC Arc Furnace	
Address 3003 Butterfield Road Oak Brook, Illinois 60521	**Operating Site** 1550 Balmer Road Model City, New York 14107	**Contact** J. K. Wittle (215) 687-9070
Process Overview The arc furnace is located at the SCA Chemical Services/Chemical Waste Management's facility at Model City, N.Y.. The furnace has been designed to destroy PCB-filled capacitors. Unopened capacitors are fed into a sealed DC arc furnace where the organic materials pyrolyze and inorganic materials melt to form a molten pool in the furnace. Off-gases are quenched, particles,and HCl removed, and the pyrolysis gas burned in an afterburner. Molten residue is tapped into mold carts and the residue is reclaimed or landfilled. Pollution control solids are removed and landfilled. Liquids are treated at the on-site aqueous waste treatment plant.	**Development Status** The facility is designed to handle 6600 to 12100 kg/h of PCB-filled capacitors. The facility will be commercial after it recieves final operating permits from EPA and New York State.	
Approval Status The facility has a permit from both New York State and the EPA to conduct trial burn tests. These are scheduled for the last half of 1987. Permit applications have been submitted to New York State and EPA for commercial operation.	**Availability Status** This facility is not accessible to Canadian wastes because of border closure to the transport of PCB waste.	

TABLE A-8 (CONT'D) ARC TECHNOLOGIES : PROCESS DESCRIPTION

Company Name Arc Technologies Co.

Technology Name Arc Furnace

Technology Type Pyrolytic DC Arc Furnace

Waste System

Waste Types Accepted
PCB-filled capacitors

MAX PCB Content
All types of PCB capacitors

MAX Total Chlorine

Waste Handling System

Capacitors are fed whole to furnace through two identical feed systems. Both feed systems take capacitors without shredding. Capacitors are fed into the furnace through a nitrogen purged first chamber to a second chamber. Purge gas from the first chamber is vented through carbon canisters to the atmosphere. In the second chamber, the capacitors are punctured prior to feeding into the furnace.

Destruction System Parameters

Feed Rate
6600 to 12100 kg/h PCB capacitors

Operating Mode
Continuous batch feed

Auxiliary Fuel

Thermal Duty 3 MW

Combustion Efficiency

Destruction Temperature
Furnace
Plasma Zone 1600 degrees C
6000 degrees C

Residence Time (Solids) Minimum 30 minutes
Residence Time (Gas) 2+ seconds

Combustion Air Rate
Not applicable

Emission Control System

General Description

Furnace off-gases pass through the plasma zone of the furnace through the hollow cathode electrode to a gas handling system. The gas handling system consists of a water cooled quench chamber, quench water knockout pot, dry cyclone scubber, induced jet venturi scrubber, two packed tower scrubbers, a water seal and finally to a flare stack.

Exhaust Flow Nominal 57 000 sm^3 per hour

HCl Removal Rate

HCl removal efficiency of 99+%

Particulate Removal Efficiency

To be determined

Liquid Residue Handling System

Water from the scrubber is supplied by a recirculation system and fresh water makeup to one quench spray nozzle and packed tower.

Solid Residue Handling System

Solid residue is tapped as a molten metal and slag from the furnace every eight hours and landfilled as a hazardous waste.

Services

Power 3 MW
Water 100 L/mim
Space 0.8 ha
Surface/Shelter
Waste Storage
Other

TABLE A-8 (CONT'D) ARC TECHNOLOGIES : PERFORMANCE DATA

Company Name	Arc Technologies Co.	**Technology Name**	Arc Furnace
		Technology Type	Pyrolytic DC Arc Furnace
Combustion Efficiency	Pyrolysis - not applicable	**Data Source**	See below
DRE	Greater than 99.9999% for PCBs		

Air Emissions

Source	Discharge at stack	**PCB**	NO_x < 3.5 kg/h	**Data Source**
Gas Flow Rate	57 000 sm^3	**PCDD** Not specified	**CO** < 3.9 kg/h	Application for permit
Gas Temperature	900 ° C at flare	**PCDF**		

Liquid Emissions

Source	**PCB**	**Other**	**Data Source**
Discharge Rate Not specified	**PCDD** Not specified		As above
Disposal	**PCDF**		

Solid Wastes

Source Ingot waste and drummed residues	**PCB**	**Data Source**
Discharge Rate Not specified	**PCDD** Not specified	As above
Disposal To permitted landfill	**PCDF**	

System Costs

Scope of Services	PCB capacitors
Capital Cost/Basis	Not specified
Destruction Cost/Basis	Not specified
Minimum Job Size	Not specified

System Mobility

Transport Configuration	
MAX Dimensions	Not applicable Stationary
MAX Load	
Site Requirements	
Lead / Setup Time	

Insurance
Not specified

Site Decommissioning
As required by NY State

TABLE A-9 ENSCO : IDENTITY AND STATUS

Company Name Ensco Environmental Services.	**Technology Name** Ensco Incinerator **Technology Type** Rotary Kiln	
Address 1015 Louisiana St Little Rock, Arkansas 72202	**Operating Site** Eldorado, Arkansas	**Contact** John Lanier (615) 794-1351
Process Overview The rotary kiln operates at 980 degrees C with a solids retention time of 45-60 minutes. Gases from the kiln enter a secondary combustion chamber which operates at 1260-1540 degrees C with a 4-9 second retention time for gases. The combustion gases enter a horizontal cyclone separator to remove coarse particulates and then passes to a quench and scrubber system which utilizes a steam jet ejector . Gases exiting the ejector pass through a demister and are discharged through a 57 metre stack. The feed system uses a shredder for size reduction of solid wastes including steel capacitor and equipment casings. Solids are then fed to the kiln. Liquid wastes are injected into the kiln or into the secondary combustion chamber. Sludges are injected by lance into the rotary kiln.	**Development Status** Ensco has operated a commercial facility for the destruction of hazardous wastes since 1964. The rotary kiln incinerator system has commercially destroyed all forms of PCB wastes since recieving EPA permits in 1981. PCB liquids,solids (including electrical capacitors and contaminated soils) are accepted for destruction at the facility.	
Approval Status The facility has an EPA Region VI permit for the commercial destruction of all forms of PCB wastes.	**Availability Status** This facility is not accessible to Canadian wastes because of border closure to the transport of PCB waste.	

TABLE A-9 (CONT'D) ENSCO : PROCESS DESCRIPTION

Company Name Ensco Environmental Services

Technology Name Ensco Incinerator

Technology Type Rotary Kiln

Waste System

Waste Types Accepted
All forms of PCB wastes

MAX PCB Content Not specified

MAX Total Chlorine Not specified

Waste Handling System

The feed system utilizes a shredder for size reduction of solid wastes including steel capacitors and equipment casings. Solids are then fed to the rotary kiln. Liquid waste is injected into the kiln or the secondary combustion chamber. Sludges are injected by lance into the rotary kiln.

Destruction System Parameters

Feed Rate
To 8140 kg/h PCBs to the kiln

Operating Mode
Continuous

Auxiliary Fuel Gas or oil

Thermal Duty Not specified

Combustion Efficiency 99.99 %

Destruction Temperature
Primary 980 ° C
Secondary 1260 to 1540 ° C

Residence Time (Solids) 45 to 60 minutes
Residence Time (Gas) 4 to 9 seconds

Combustion Air Rate
Not applicable

Emission Control System

General Description

The combustion off-gases enter a horizontal cyclone separator to remove coarse particulates and then passes to a quench and scrubber system which uses a steam jet ejector. Gases exiting the ejector pass through a demister and are discharged through a 57 metre stack.

Exhaust Flow Not specfied

HCl Removal Rate
Removal efficiency of 99.8 %

Particulate Removal Efficiency
Greater than 99 %

Liquid Residue Handling System

The scrubber is discharged to an evaporative sludge lagoon. This lagoon is a closed system.

Solid Residue Handling System

Ash and solid residue are discharged to a permitted landfill if PCB content is less than 50 ppm. They must be reincinerated if they are greater than 50 ppm PCB.

Services

Power
Water
Space Not specified
Surface/Shelter
Waste Storage
Other

TABLE A-9 (CONT'D ENSCO : PERFORMANCE DATA

Company Name Ensco Environmental Services	**Technology Name** Ensco Incinerator
	Technology Type Rotary Kiln
Combustion Efficiency 99.99 % **DRE** Greater than 99.9999% for PCBs	**Data Source** Ensco

Air Emissions

Source Discharge at stack	**PCB** Not specified	**NO_x** < 18 kg/h	**Data Source**	
Gas Flow Rate Not specified	**PCDD** 0.17 ng/Nm^3	**CO** < 10 ppm	Results of 1979 and 1980 trial burns	
Gas Temperature	**PCDF** 2.1 ng/Nm^3	**Particulate** 10 to 68 kg/h		

Liquid Emissions

Source Scrubber liquid	**PCB**	**Other**	**Data Source**
Discharge Rate Not specified	**PCDD** Not specified		As above
Disposal To zero discharge lagoon	**PCDF**		

Solid Wastes

Source Kiln ash and cyclone particulate	**PCB**	**Data Source**
Discharge Rate Not specified	**PCDD** Not specified	As above
Disposal To permitted landfill	**PCDF**	

System Costs

Scope of Services	Commercial PCB waste destruction
Capital Cost/Basis	Not specified
Destruction Cost/Basis	$350 to 1000 US/tonne
Minimum Job Size	Not specified

System Mobility

Transport Configuration		**Insurance**
MAX Dimensions	Not applicable: Stationary	Not specfied
MAX Load		**Site Decommissioning**
Site Requirements		As required by EPA
Lead / Setup Time		

TABLE A-10 HIM : IDENTITY AND STATUS

Company Name Hessian Industrial Waste Inc. (HIM)	**Technology Name** HIM Incinerator **Technology Type** Rotary Kiln	
Address Biebeshiem, West Germany	**Operating Site** Biebeshiem, West Germany	**Contact**
Process Overview The HIM industrial waste rotary kiln incinerator is capable of destroying liquids, sludges and solids including PCB The rotary kiln has a secondary combustion chamber, a waste heat boiler, and a flue gas treatment system. The flue gas treatment includes a spray dryer, a cyclone separator, a 3-stage scrubber and a mist eliminator. Final discharge is via a 75 metre stack.	**Development Status** The HIM facility is a regional commercial hazardous waste treatment facility which accepts industrial wastes including all forms of PCB wastes. The facility provides physical/chemical treatment and high temperature incineration as required by waste type. Total incineration capacity is 40,500 tonnes per year. The facility has been in commercial operation since 1982.	
Approval Status The facility operates under West German environmental regulations.	**Availability Status** The facility accepts only wastes from within West Germany.	

TABLE A-10 (CONT'D) HIM : PROCESS DESCRIPTION

Company Name HIM

Technology Name HIM Incinerator

Technology Type Rotary Kiln

Waste System

Waste Types Accepted
All forms of PCB wastes

MAX PCB Content Not specified

MAX Total Chlorine Not specified

Waste Handling System

Liquids and sludges are introduced into the rotary kiln by lances. Solids are introduced into the kiln feed chute and then pass through an interlock system into the kiln.

Destruction System Parameters

Feed Rate (Total Wastes)
Solids and sludges 2000 kg/h
Liquids 1600 L/h
Aqueous organics 2300 L/h

Operating Mode
Continuous

Auxiliary Fuel Oil

Thermal Duty Not specified

Combustion Efficiency >99.99 %

Destruction Temperature
Primary 1100 to 1300 ° C
Secondary 900 ° C

Residence Time (Solids)
Residence Time (Gas) Not specified

Combustion Air Rate
Not specified

Emission Control System

General Description

Wasteheat boiler reduces the flue gas temperature to 250 degrees C. Flue-gases are treated in a brine-wash spray dryer. A cyclone removes particulates and metal salts. HCl and HF are removed in the first two stages of a 3-stage scrubber. A final stage removes SO2. The stack is 75 metres high.

Exhaust Flow Approx. 53 000 Nm^3/h

HCl Removal Rate
Removal efficiency of 95 %

Particulate Removal Efficiency
Not specified

Liquid Residue Handling System

The scrubber effluent is recycled to the spray dryer, no liquid effluent.

Solid Residue Handling System

Landfill

Services

Power
Water
Space
Surface/Shelter
Waste Storage
Other
Not specified

TABLE A-10 (CONT'D HIM : PERFORMANCE DATA

Company Name HIM	**Technology Name** HIM Incinerator
	Technology Type Rotary Kiln
Combustion Efficiency 99.99 % **DRE** Greater than 99.9999% for PCBs	**Data Source** See below

Air Emissions

Source Discharge at stack **Gas Flow Rate** 53 000 Nm^3/h **Gas Temperature** Not specified	**PCB** Not specified **NO$_X$** Not specified **PCDD** 0.57 ng/Nm^3 **CO** **PCDF** 16.2 ng/Nm^3 **Particulate** Not specified	**Data Source** Results of 1984 and 1983 emission tests.

Liquid Emissions

Source The dry scubber system does not produce an effluent. **Discharge Rate** **Disposal**	**PCB** **Other** **PCDD** Not applicable **PCDF**	**Data Source** As above

Solid Wastes

Source Kiln ash, boiler ash, cyclone particulate **Discharge Rate** Not specified **Disposal** To landfill	**PCB** **PCDD** Not specified **PCDF**	**Data Source** As above

System Costs

Scope of Services	Commercial waste destruction
Capital Cost/Basis	Not specified
Destruction Cost/Basis	Not specified
Minimum Job Size	Not specified

System Mobility

Transport Configuration	
MAX Dimensions	Not applicable: Stationary
MAX Load	
Site Requirements	
Lead / Setup Time	

Insurance	Not specfied
Site Decommissioning	Not specified

TABLE A-11 KOMMUNEKEMI : IDENTITY AND STATUS

Company Name Kommunekemi	**Technology Name** Kommunekemi Incinerator **Technology Type** Rotary Kiln	
Address Nyborg, Denmark	**Operating Site** Nyborg, Denmark	**Contact** A. Kristensen
Process Overview The Kommunekemi facility has two rotary kiln incinerators fot the destruction of organic hazardous wastes including PCBs. Both incinerators operate at 1200 ° C in the kilns and at 950 ° C in the secondary combustion chambers. The older kiln, installed in1975, has an electrostatic precipitator and a 60 metre stack. The 1982 kiln has a spray dryer, electrostatic precipitator and a 60 metre stack. The spray dryer has a control efficiency for HCl of greater than 95%. Solid residues (kiln slag, boiler ash, cyclone and precipitator ash) are landfilled.	**Development Status** The facility is a regional commercial hazardous waste treatment facility which accepts industrial wastes including all forms of PCB wastes. Total incinerator capacity is 80 000 tonnes per year. The facility has been in operation since 1975.	
Approval Status The facility operates under Danish environmental regulations.	**Availability Status** The facility accepts only wastes from within Denmark.	

TABLE A-12 ONTARIO WASTE MANAGEMENT CORP. : IDENTITY AND STATUS

Company Name Ontario Waste Management Corp..	**Technology Name** OWMC Incinerator **Technology Type** Rotary Kiln	
Address 2 Bloor St. West, 11th Floor Toronto, Ontario	**Operating Site** West Lincoln, Ontario	**Contact** E. Schmidt (416) 923-2913
Process Overview The OWMC hazardous waste incinerator facility will provide the capability of destroying organic hazardous waste in two identical rotary kiln systems. Each kiln system includes: i) a waste feed system to accept liquids, sludges and solids including bulk solids, ii) a rotary kiln primary combustion chamber with a temperature of 1000 to 1400°C. A secondary combustion chamber will operate at 1100°C. Together the two chambers will provide a gas residence time of greater than 2 seconds. iii) a waste heat recovery boiler, iv) a flue gas treatment system comprised of a spray dryer, an electrostatic precipitator and a three-stage wet scrubber. This system will remove acid gases, particulate and sulphur dioxide.	**Development Status** The project is currently at the engineering design stage. Selected kiln design is a rotary kiln by Von Roll. The system is based on experience at the HIM facility in West Germany.	
Approval Status No formal applications/submissions to date. Possible schedule is: i) Environmental Assessment Document Submission - 1989 ii) Environmental Hearing - 1989 iii) Project Certificate of Approval - 1990	**Availability Status** Anticipated start of commercial operation is 1991.	

TABLE A-12 (CONT'D) : OWMC PROCESS DESCRIPTION

Company Name Ontario Waste Management Corp.

Technology Name OWMC Incinerator

Technology Type Rotary Kiln

Waste System

Waste Types Accepted
All forms of PCB wastes

MAX PCB Content Not specified

MAX Total Chlorine Not specified

Waste Handling System

Sludges: lances into kiln
Liquids: atomizing lances into kiln
Solids: feed chute with an air lock

Destruction System Parameters

Feed Rate (Total Wastes)
Total nominal capacity of 9600 kg/h for 2 kilns
4300 kg/h per kiln

Operating Mode
Continuous

Auxiliary Fuel Gas or oil

Thermal Duty 18.6 MW

Combustion Efficiency >99.99 %

Destruction Temperature
Primary > 1100 ° C (design)
Secondary Not specified

Residence Time (Solids) Not specified
Residence Time (Gas) 2 seconds (Design)

Combustion Air Rate
Not specified

Emission Control System

General Description

Wasteheat boiler reduces the flue gas temperature to 250 degrees C. Flue-gases are treated in a brine-wash spray dryer. A cyclone removes particulates and metal salts. HCl and HF are removed in the first two stages of a 3-stage scrubber. A final stage removes SO2. The stack is 75 metres high.

Exhaust Flow Approx. 24 000 Nm^3/h per kiln

HCl Removal Rate

Removal efficiency of 95 %

Particulate Removal Efficiency

Not specified

Liquid Residue Handling System

Scrubber effluent is recycled to the spray dryer and evaporated, no liquid effluent.

Solid Residue Handling System

Kiln ash: to landfill
Boiler ash, dryer and precipitator salts: to solidification and then landfill

Services

Power
Water
Space
Surface/Shelter
Waste Storage
Other

Not specified

TABLE A-12 (CONT'D) : OWMC PERFORMANCE DATA

Company Name Ontario Waste Management Corp.	**Technology Name** OWMC Incinerator
	Technology Type Rotary Kiln
Combustion Efficiency Not specified **DRE** Greater than 99.9999% for PCBs	**Data Source** see below

Air Emissions

Source Discharge at stack **Gas Flow Rate** 24 000 Nm^3/h per kiln **Gas Temperature** 130 ° C	**PCB** **PCDD** Not specified **PCDF**	**NO_X** Not specified **CO** **Particulate** Not specified	**Data Source** Monenco Status Report/Facility Design - 1986

Liquid Emissions

Source The dry scubber system does not produce an effluent. **Discharge Rate** **Disposal**	**PCB** **PCDD** Not applicable **PCDF**	**Other**	**Data Source** As above

Solid Wastes

Source Kiln ash, boiler ash, precipitator salt **Discharge Rate** Not specified **Disposal** To landfill	**PCB** **PCDD** Not specified **PCDF**		**Data Source** As above

System Costs	**Scope of Services** Commercial waste destruction **Capital Cost/Basis** Not specified **Destruction Cost/Basis** Not specified **Minimum Job Size** Not specified	**System Mobility**	**Transport Configuration** **MAX Dimensions** Not applicable: Stationary **MAX Load** **Site Requirements** **Lead / Setup Time**
			Insurance Not specfied **Site Decommissioning** Not specified

TABLE A-13 PYROCHEM : IDENTITY AND STATUS

Company Name Pyrochem	**Technology Name** Pyrochem Incinerator **Technology Type** Rotary Kiln	
Address P. O. Box 907 Coffeyville, KS 67337	**Operating Site** U.S. Route 169 North Industrial Park, Coffeyville, KS	**Contact** R. Wolf (613) 251-4782
Process Overview The Pyrochem facility consists of a slagging rotary kiln, followed by an afterburner and a gas cleaning train. The plant is permitted to incinerate PCB containing solids and liquids. Solids are fed to the kiln only, while liquids are pumped to the kiln and the afterburner simultaneously. Gases are drawn through the incinerator by an induced draft fan into a quench tank which drops the temperature prior to entering the cross flow scrubber for acid neutralization. The solids are removed from the vapours in two ionic wet scrubbers, in series, prior to being discharged through a 23 metre stack. The kiln slag and the filter cake from the scrubber liquid are shipped in end-dump trailers to a commercial hazardous waste landfill.	**Development Status** Construction of the Pyrochem incinerator began in 1985 with the heatup of the kiln beginning in1986. The first trial burn was conducted in Sept. 1986 and commercial operation was permitted shortly thereafter.	
Approval Status The facility is permitted by the the EPA and the Kansas Dept. of Health and Environment to operate commercially.	**Availability Status** This facility is not accessible to Canadian wastes because of the border closure to the transport of PCB wastes.	

TABLE A-14 ROLLINS : IDENTITY AND STATUS

Company Name Rollins Environmental Services.	**Technology Name** Rollins Incinerator **Technology Type** Rotary Kiln	
Address 2027 Battleground Road (P.O. Box 609) Deer Park, Texas 77536	**Operating Site** Deer Park, Texas	**Contact** George Hirtz (713) 479-6001
Process Overview The Deer Park incineration facility utilizes two primary combustion chambers for different forms of waste feed. The main combustion chamber is a liquid injection incinerator, the second is a rotary kiln. The rotary kiln is used for the destruction of liquids, sludges, solids contained in fiber-pak containers. Both systems use natural gas as supplementary fuel. Combustion gases from both systems pass through a common afterburner. The gases are then cleaned in a wet venturi scrubber, flexitray and demister prior to being discharged to the atmosphere through a 30 metre stack.	**Development Status** The Rollins Deer Park facility is a regional, commercial treatment plant established in 1981 which accepts hazardous industrial wastes, including all forms of PCB wastes. The facility provides biological degradation, physical/chemical treatment,land disposal and high temperature incineration as required by waste type. All PCB wastes are destroyed by incineration.	
Approval Status The facility has an EPA and state permit for the commercial destruction of all forms of PCB wastes.	**Availability Status** This facility is not accessible to Canadian wastes because of border closure to the transport of PCB waste.	

TABLE A-14 (CONT'D) ROLLINS : PROCESS DESCRIPTION

Company Name Rollins Environmental Services

Technology Name Rollins Incinerator

Technology Type Rotary Kiln

Waste System

Waste Types Accepted
All forms of PCB wastes

MAX PCB Content Not specified

MAX Total Chlorine Not specified

Waste Handling System

Liquid wastes are blended and injected directly to the kiln burner. Sludges and solid wastes are packaged in fiber drums and fed to the rotary kiln. PCB capacitors are shredded prior to feeding to the kiln.

Destruction System Parameters

Feed Rate (Total Wastes)
Liquids : 2300 L/h
Solids : 1110 kg/h

Operating Mode
Continuous

Auxiliary Fuel Gas

Thermal Duty Not specified

Combustion Efficiency >99.99 %

Destruction Temperature
Primary 1300 ° C
Secondary 1150 ° C

Residence Time (Solids) Not specified
Residence Time (Gas) 2 to 3 seconds

Combustion Air Rate
Not specified

Emission Control System

General Description

The combustion gases are cleaned in a wet venturi scrubber, flexitray and demister prior to being discharged to the atmosphere through a 30 metre stack. The treatment of a scrubber system liquids and ash and solid residues was not specified.

Exhaust Flow Not specified

HCl Removal Rate

Removal efficiency of greater than 99 %, max. emission of 18 kg/h.

Particulate Removal Efficiency

Not specified

Liquid Residue Handling System

Not specified

Solid Residue Handling System

Not specified

Services

Power
Water
Space
Surface/Shelter
Waste Storage
Other

Not specified

TABLE A-14 (CONT'D) : ROLLINS PERFORMANCE DATA

Company Name Rollins Environmental Services		**Technology Name** Rollins Incinerator **Technology Type** Rotary Kiln	
Combustion Efficiency 99.9 % **DRE** Greater than 99.9999% for PCBs			**Data Source** see below
Air Emissions			
Source Discharge at stack **Gas Flow Rate** Not specified **Gas Temperature**	**PCB** Not specified **NO_x** Not specified **PCDD** 0.636 ng/Nm^3 **CO** 38 ppm max. **PCDF** 9.92 ng/Nm^3		**Data Source** Trial burns in 1979 and 1980.
Liquid Emissions			
Source Scrubber system discharge **Discharge Rate** Not specified **Disposal**	**PCB** Less than detection limit (not specified) **Other** **PCDD** **PCDF**		**Data Source** As above
Solid Wastes			
Source Kiln ash and scrubber solid residues **Discharge Rate** Not specified **Disposal** Not specified	**PCB** **PCDD** Less than detection limit (not specified) **PCDF**		**Data Source** As above
System Costs **Scope of Services** Commercial waste destruction **Capital Cost/Basis** $25 million US (1982) **Destruction Cost/Basis** Not specified **Minimum Job Size** Not specified	**System Mobility** **Transport Configuration** **MAX Dimensions** Not applicable: Stationary **MAX Load** **Site Requirements** **Lead / Setup Time**		**Insurance** Not specified **Site Decommissioning** Not specified

TABLE A-15 RECHEM : IDENTITY AND STATUS

Company Name ReChem International Ltd.	**Technology Name** ReChem Incinerator **Technology Type** Unspecified	
Address c/o International Environmental Materials (IEM)Corp. 9241 - 35 Ave. Edmonton, Alberta T6E 5Y1	**Operating Site** Pontypool, Great Britian	**Contact** IEM Corp. - B. Winters (403) 450-2010
Process Overview IEM Corp. provides a PCB waste disposal service. Wastes are shipped to the ReChem Int'l hazardous waste treatment facility in Pontypool, Wales for destruction.	**Development Status** IEM Corp. have offered this PCB waste disposal service since 1986. To date, 22 shipments totalling over 238 tonnes have taken place.	
Approval Status Shipment of waste is regulated by the Transportation of Dangerous Goods Act and the International Maritimes Dangerous Goods Code. Importation and destruction of the wastes is permitted by the Control of Pollution (Special Wastes) Regulations 1980 of Great Britian.	**Availability Status** This disposal/destruction service is currently available in Canada through IEM Corp.	

TABLE A-16 SAKAB : IDENTITY AND STATUS

Company Name Svensk Aufallskenvertering AB (SAKAB).	**Technology Name** SAKAB Incinerator **Technology Type** Rotary Kiln	
Address Norrtrop, Sweden	**Operating Site** Norrtrop, Sweden	**Contact** L. Ljung
Process Overview The SAKAB facility has a rotary kiln incinerator for the destruction of hazardous wastes including PCB wastes. The kiln operates at 1000-1300 ° C and the secondary combustion chamber at 1000 ° C. A waste heat boiler recovers flue-gas heat after secondary combustion. The first treatment stage is a brine wash scrubber, followed by an electrostatic precipitator and the exhaust gases discharge through a 60 metre stack. The system was designed to accept 100 tonnes per year of PCB wastes.	**Development Status** The SAKAB facility is a national commercial hazardous waste treatment facility which accepts industrial wastes including PCB wastes. The facility has been in operation since 1983.	
Approval Status The facility operates under Swedish environmental regulations.	**Availability Status** The facility accepts wastes only from within Sweden.	

TABLE A-17 SELENCO : IDENTITY AND STATUS

Company Name Selenco/Sanivan Group	**Technology Name** Selenco MWP2000 **Technology Type** Rotary Kiln	
Address 7777 Louis H Lafontaine Blvd Anjou, P.Q. H1K 4E4	**Operating Site** Senneterre, Quebec	**Contact** P. Lefebure (514) 355-3351
Process Overview Selenco/Sanivan are planning to operate an Ensco/Pyrotech MWP2000 transportablerotary kiln incinerator in the stationary mode at this Senneterre facility. The incinerator will handle all organic hazardous wastes including PCB wastes. Electrical equipment with PCB-contaminated oil of greater than 3300 ppm PCB will be drained and flushed and the carcasses schredded for metals recovery. This PCB-contaminated oil together with solvent washings will be destroyed in the rotary kiln. The rotary kiln will also accept other PCB wastes such as liquids, soils, sludges, and misc. solids. PCB-contaminated oil of less than 3300 ppm PCB will be treated with an oil treatment process.	**Development Status** An application has been submitted for the commercial operation of the rotary kiln incinerator. See Table A-19 for details on the MWP2000 system. Construction is anticipated prior to late 1989.	
Approval Status The Senneterre site has received approval from Quebec for the storage of PCB wastes. An application has been submitted for the commercial operation of the proposed rotary kiln incinerator.	**Availability Status** It is anticipated that the facility will be available for the storage of PCB wastes by 1988. It is also anticipated that the destruction of PCB wastes will commence in 1990.	

TABLE A-18 SCA CHEMICAL SERVICES : IDENTITY AND STATUS

Company Name SCA Chemical Services Chemical Waste Management Inc.	**Technology Name** SCA Chemical Incinerator	
	Technology Type Rotary Kiln	
Address 11700 South Stony Island Ave Chicago, Illinois 606617	**Operating Site** Chicago, Illinois	**Contact** Bill Clark (312) 841-8360
Process Overview The Chicago SCA facility consists of a two-stage incineration system incorporating a rotary kiln and a secondary combustion chamber with a total thermal capacity exceeding 34 MW. The system can accept organic wastes as liquids, sludges and solids. Solids and sludges are fed to the kiln and liquid wastes are injected directly into the afterburner . Off-gases pass through a primary cyclone removes particulates. The gases then enter the counter-current packed tower scrubbers which remove acid gases. Four ionizing gas scrubbers are used to remove any remaining particulate and gaseous contaminants. Ash and solid residue from the destruction process are sent to SCA's Indiana landfill site. Water for the scrubber is supplied from a recirculating system which inludes two cooling tower basins. Wastewater from the reciculating loop is treated in a Lamella separator and the underflow passes through a setting basin and is discharged to the Chicago municipal sewer system.	**Development Status** This commercial facility is designed to handle 150 000 litres of organic waste daily and was intended to serve industrial clients in the area east of the Mississippi River. This facility began commercial destruction of PCB wastes in 1983. The facility can accept PCB liquids with up to 25% by weight PCB and solids containing up to 28.5% by weight PCB.	
Approval Status The facility has EPA and State permits for the commercial destruction of PCB wastes.	**Availability Status** This facility is not accessible to Canadian wastes because of border closure to the transport of PCB waste.	

TABLE A-18 (CONT'D) SCA CHEMICAL SERVICES : PROCESS DESCRIPTION

Company Name SCA Chemical Services

Technology Name SCA Chemical Incinerator

Technology Type Rotary Kiln

Waste System

Waste Types Accepted
All forms of PCB wastes

MAX PCB Content
PCB liquids : 25% by wt.
PCB non-liquids : 28.5% by wt.

MAX Total Chlorine
Liquids:chlorine < 30% by wt.
Solids : chlorine < 35% by wt.

Waste Handling System

Pumpable sludges are introducted to the kiln through two lances into the kiln.
Bulked wates are fed to the kiln to a feed hopper and charged to the kiln with a ram feed. A solid waste shredder prepares drummed wastes and capacitors for the kiln.

Destruction System Parameters

Feed Rate
Liquid PCBs : 2730 kg/h
Solid PCB solids : 1320 kg/h

Operating Mode
Continuous

Auxiliary Fuel Oil

Thermal Duty 34 MW

Combustion Efficiency 99.9 %

Destruction Temperature
Primary 870 to 980 degrees C
Secondary 1100 to 1260 degrees C

Residence Time (Solids) Not specified
Residence Time (Gas) 2 seconds minimum

Combustion Air Rate
Not specified

Emission Control System

General Description

Off-gases pass through a primary quench chamber which cools the gases and removes particulates. The gases then enter counter-current packed tower scrubbers which remove the acid gases. Four ionizing gas scrubbers are used to remove the remaining particulates and gaseous contaminants.

Exhaust Flow Not specified

HCl Removal Rate

Removal efficiency of greater than 99 %

Particulate Removal Efficiency

Particulate emissions are less than 137.7 mg/Nm3

Liquid Residue Handling System

Scrubber water is supplied from a recirculating system including 2 cooling tower basins. Wastewater is treated in a Lamella separator and the underflow passes through a separator basin and is discharged to the Chicago sewer system at an average of 20 400 L/h.

Solid Residue Handling System

Solid residue and ash from the incinerator is discharged to a hazardous landfill.

Services

Power
Water
Space
Surface/Shelter
Waste Storage
Other

Not specified

TABLE A-18 (CONT'D) SCA CHEMICAL SERVICES : PERFORMANCE DATA

Company Name SCA Chemical Services		**Technology Name** SCA Chemical Incinerator **Technology Type** Rotary Kiln	
Combustion Efficiency 99.9 % **DRE** Greater than 99.9999% for PCBs			**Data Source** see below
Air Emissions			
Source Discharge at stack **Gas Flow Rate** Not specified **Gas Temperature**		**PCB** Not specified **NO_X** Not specified **PCDD** **CO** 8.3 ppm average **PCDF** Not specified	**Data Source** Trial burns in 1982.
Liquid Emissions			
Source Scrubber system discharge **Discharge Rate** 20 400 L/h **Disposal** Municipal sewer system		**PCB** Less than 2 ppm **Other** **PCDD** **PCDF** Not specified	**Data Source** As above
Solid Wastes			
Source Kiln ash and scrubber solid residues **Discharge Rate** Not specified **Disposal** Not specified		**PCB** 16 ppm **PCDD** **PCDF** Not specified	**Data Source** As above
System Costs	**System Mobility**		
Scope of Services Commercial waste destruction **Capital Cost/Basis** Not specified **Destruction Cost/Basis** Liquids:$550-1000 US/t Solids: $1100-1200 US/t **Minimum Job Size** Not specified	**Transport Configuration** **MAX Dimensions** Not applicable: Stationary **MAX Load** **Site Requirements** **Lead / Setup Time**		**Insurance** Not specified **Site Decommissioning** As required by EPA permit

TABLE A-19 ENSCO MWP2000 : IDENTITY AND STATUS

Company Name Ensco Environmental Services	**Technology Name** Ensco MWP2000 **Technology Type** Rotary Kiln	
Address First Tennessee Bank Building Franklin, TN 37064	**Operating Site** Transportable	**Contact** J. Lanier (615) 794-1351
Process Overview The destruction system consists of six trailer-mounted modules: 1. a rotary kiln 2. a secondary combustion chamber 3. a waste heat recovery boiler 4. a packed tower and scrubber for cleaning flue gases 5. a control room and laboratory 6. a system for neutralizing the scrubber water The MWP2000 was designed for hazardous waste destruction and can accept a wide variety of waste types including liquids, sludges, soils and solid wastes including PCB capacitors. The unit has a rated capacity of 900 kg/h solids and/or 680 kg/h liquids.	**Development Status** The design of the MWP2000 is based on the experience gained with Pyrotech's liquid injection incinerators. The first MWP2000 unit was built in1984 and then operated commercially on non-PCB wastes at a site in Florida. A total of 7700 tonnes of waste were destroyed by the MWP2000 todate. EPA trial burns were conducted in 1986 and 1987.	
Approval Status The system has operated commercially with State permits for non-PCB wastes. Trial burns were conducted in 1986 and 1987. An EPA permit for commercial PCB destruction is pending.	**Availability Status** There are currently three commercial MWP2000 units. At present there is no Canadian representation. The Selenco/Sanivan Group are proposing to use MWP2000 units in Canada in both the transportable and stationary modes.	

TABLE A-19 (CONT'D) ENSCO MWP2000 : PROCESS DESCRIPTION

Company Name Ensco Environmental Services

Technology Name Ensco MWP2000

Technology Type Transportable Rotary Kiln

Waste System

Waste Types Accepted
All forms of PCB wastes.

MAX PCB Content Not specified

MAX Total Chlorine 680 kg/h

Waste Handling System
Solids Feed: Preparation as required. Drag chain or belt conveyor to a hopper which discharges to a ram or screw feed to the kiln. The entire system operates under negative pressure to prevent release of gases.
Sludge Feed: Progressive cavity pump feed to the kiln with steam or compressed air atomization as required.
Liquid Feed: Nozzle feed of waste and auxillary feed.

Destruction System Parameters

Feed Rate
900 kg/h solids , 680 kg/h liquids

Operating Mode Continuous

Auxiliary Fuel Oil / gas

Thermal Duty Kiln 4 MW, Secondary 7 MW

Combustion Efficiency >99.99 %

Destruction Temperature

Primary	980 °C
Secondary	1200 °C

Residence Time (Solids)	30 to 60 minutes
Residence Time (Gas)	2.5 seconds

Combustion Air Rate
Not specified

Emission Control System

General Description
Cyclone separators for the removal of kiln ash during soil incineration. Packed tower and ejector scrubber for acid gas control.

Exhaust Flow 80 000 am3/h at 1200°C

HCl Removal Rate
680 kg/h

Particulate Removal Efficiency
99% removal of greater than 0.3 µm particles

Liquid Residue Handling System
Scrubber effluent is nuetralized and discharged as a dilute salt solution, or is concentrated by steam evaporation to 50%, and disposal as required.

Solid Residue Handling System
Not specified

Services

Power	400 KVA
Water	132 L/mi
Space	60 m x 60 m
Surface/Shelter	Not specified
Waste Storage	Site specific
Other	

TABLE A-19 (CONT'D) ENSCO MWP2000 : PERFORMANCE DATA

Company Name	Ensco Environmental Services	**Technology Name**	Ensco MWP2000
		Technology Type	Transportable Rotary Kiln
Combustion Efficiency	99.99 %	**Data Source**	see below
DRE	Greater than 99.9999% for PCBs		

Air Emissions

Source	Discharge at stack	**PCB**	Not specified **NO_X** Not specified	**Data Source**
Gas Flow Rate	Not specified	**PCDD**	Not specified **CO**	Ensco literature, J. Lanier
Gas Temperature	77 °C	**PCDF**		

Liquid Emissions

Source	Scrubber system discharge	**PCB**	Not specified **Other**	**Data Source**
Discharge Rate	Not specified	**PCDD**		As above
Disposal	As required	**PCDF**	Not specified	

Solid Wastes

Source	Kiln ash and scrubber solid residues	**PCB**	Not specified	**Data Source**
Discharge Rate	Not specified	**PCDD**		As above
Disposal	Not specified	**PCDF**	Not specified	

System Costs

Scope of Services	Transportable commercial waste destruction
Capital Cost/Basis	Not specified
Destruction Cost/Basis	$350 to 1000 US/tonne
Minimum Job Size	2300 m^3

System Mobility

Transport Configuration	Six flat bed trailers
MAX Dimensions	Not specified
MAX Load	
Site Requirements	
Lead / Setup Time	4 to 6 weeks on-site setup

Insurance

Provided by Ensco

Site Decommissioning

As required.

TABLE A-20 HAZTECH : IDENTITY AND STATUS

Company Name Haztech, Inc.	**Technology Name** Haztech Infrared Unit **Technology Type** Shirco Infrared Energy	
Address 5280 Panda Industrial Blvd. Decatur, GA 30035	**Operating Site** Transportable	**Contact** C. Love (404) 981-9332
Process Overview Haztech purchased a 110 tonne per day Shirco transportable infrared energy system for the cleanup of the Peak Oil waste site at Brandon, Fl. The system is setup in a stationary mode with material handling facilities and primary and secondary furnaces enclosed for weather protection. The system will remain at this waste site until cleanup is completed.	**Development Status** Site preparation was completed in Dec. 1986 at the Florida (Peak Oil) site with startup for non-PCB wastes in early 1987. A permit application has been submitted. for the destruction of PCB wastes. Approval is anticipated by late 1987.	
Approval Status The Haztech unit has approval for non-PCB wastes and an EPA commercial PCB destruction permit is pending. PCB trial burns were conducted in 1987.	**Availability Status** Currently Haztech does not have Canadian representation.	

TABLE A-21 : IT CORP : IDENTITY AND STATUS

Company Name International Technology Corp. (IT Corp)	**Technology Name** IT Incinerator **Technology Type** Rotary Kiln	
Address 321 Directors Drive Knoxville, TN 37923	**Operating Site** Transportable	**Contact** J. Riordan (615) 690-3211
Process Overview IT Corp. have designed and built a large (16.5 MW) transportable modular rotary kiln for use at Superfund sites for the decontamination of soils.	**Development Status** One system has been built and has operated commercially at a Superfund site for the destruction of non-PCB wastes. Additional units are planned.	
Approval Status The system has approval for non-PCB wastes. PCB trial burns were scheduled for 1987.	**Availability Status** Currently there is no Canadian representation for mobile/transportable systems.	

TABLE A-22 OGDEN : IDENTITY AND STATUS

Company Name Ogden Environmental Services Inc.	**Technology Name** Ogden Circulating Combustor	
	Technology Type Circulating Bed Combustor (CBC)	
Address P.O. Box 85178 San Diego, CA 92138-5178	**Operating Site** Transportable	**Contact** Harold Doit (619) 455-2383
Process Overview Ogden purchased the CBC technology from GA Technologies. Combustible material such as hazardous wastes including PCBs as solids, liquids and sludges are burned ina bed of limestone and inert material. The bed material is continuously circulated through an cyclone separator to separate the solids from the combustion off-gas, and the bed is returned to the combustion zone through a non-mechanical seal. Off-gases and fine particulates pass through an off-gas cooler afer leaving the cyclone, and fines are removed in a baghouse. The use of dry limestone as part of the bed medium controls acid gases and eliminates the requirement for wet scrubbers.	**Development Status** The application of CBC technology to hazardous waste incineration by Ogden has been under development since 1981. Tests have been performed on several hazardous wastes in a 40-cm internal diameter CBC pilot plant. Although permitted for the commercial destruction of PCB-contaminated soils, the system has currently not operated commercially.	
Approval Status Ogden have an EPA permit for the commercial destruction of PCBs in soils containing up to 10 000 ppm PCB in a transportable 40-cm unit.	**Availability Status** Ogden offers a full-service hazardous waste incineration capability using the CBC system. One transportable 90-cm unit will be available in February 1988 and two others are in production. The Ogden CBC system is available in Canada through Ogden Allied Canada, Inc., Toronto.	

TABLE A-22 (CONT'D) OGDEN : PROCESS DESCRIPTION

Company Name Ogden Environmental Services

Technology Name Ogden CBC (40 cm Pilot Plant)

Technology Type Transportable Circulating Bed Combustor

Waste System

Waste Types Accepted
Liquids, solids, sludges.

MAX PCB Content 10 000 ppm tested to date

MAX Total Chlorine 5% by wt tested to date

Waste Handling System

Liquids : centrifugal pump feed
Sludges : screw and diaphram pump feed
Solids : auger, pneumatic feed

Destruction System Parameters

Feed Rate 680 kg/h soil

Operating Mode Continuous

Auxiliary Fuel Gas

Thermal Duty 0.6 MW

Combustion Efficiency >99.9 %

Destruction Temperature
Primary 870 to 980 ° C
Secondary Not applicable

Residence Time (Solids) Not Specified
Residence Time (Gas) 1 to 2 seconds

Combustion Air Rate
590 Nm^3/h

Emission Control System

General Description

Acid gases are absorbed by limestone in the circulating bed. Fines removal is with a baghouse.

Exhaust Flow 850 Nm^3/h

HCl Removal Rate

Removal efficiency of > 99 %

Particulate Removal Efficiency

Particulate concentrations in the exhaust gases of less than 180 mg/m^3 at 177°C.

Liquid Residue Handling System

Not specified

Solid Residue Handling System

Combustor ash : Cooled via a cooling auger, discharged to 200 litre drums
Baghouse ash : Discharged to 200 litre drums

Services

Power	Not specified
Water	Not specified
Space	12 m x 15 m
Surface/Shelter	Not specified
Waste Storage	As required
Other	

TABLE A-22 (CONT'D) OGDEN : PERFORMANCE DATA

Company Name Ogden Environmental Services Inc.	**Technology Name** Ogden CBC (40 cm Pilot Plant)
	Technology Type Transportable Circulating Bed Combustor
Combustion Efficiency 99.9 % **DRE** Greater than 99.9999 % for PCBs	**Data Source** see below

Air Emissions

Source Discharge at stack **Gas Flow Rate** 850 Nm^3/h at **Gas Temperature** 177 °C	**PCB** <0.49 µg/Nm3 **NO_x** 50 ppm average **PCDD** Below detection limit **CO** 30 ppm average **PCDF** (not specified)	**Data Source** PCB trial burns on 10,000 ppm soil

Liquid Emissions

Source No liquids effluent **Discharge Rate** Not applicable **Disposal**	**PCB** **Other** **PCDD** Not applicable **PCDF**	**Data Source** As above

Solid Wastes

Source Combustor ash and baghouse **Discharge Rate** 230 kg/h **Disposal** Landfill	**PCB** < 0.2 ppm **PCDD** **PCDF** Below detection limit (not specified)	**Data Source** As above

System Costs

Scope of Services Transportable commercial waste destruction **Capital Cost/Basis** Not specified **Destruction Cost/Basis** $120 to 200 US/tonne **Minimum Job Size** Not specified	**System Mobility** **Transport Configuration** Several trailers **MAX Dimensions** Not specified **MAX Load** **Site Requirements** **Lead / Setup Time** 4 to 6 weeks on-site set-up	**Insurance** Not specified **Site Decommissioning** Not specified

TABLE A-23 OHM : IDENTITY AND STATUS

Company Name O.H. Materials, Inc.	**Technology Name** OHM Infrared Unit **Technology Type** Shirco Infrared Energy	
Address O.H. Materials of Canada Ltd. 2180 Speers Road P.O. Box 7010 Oakville, Ont. L6J 6L5	**Operating Site** Transportable	**Contact** G. Gardner (416) 847-1700
Process Overview O H Materials purchased a 110 tonne per day Shirco transportable infrared energy system for a Superfund site in Florida. The unit will be used to treat soil contaminated with PCBs.	**Development Status** O H Materials have received delivery of the Shirco unit and trial burns are planned for late 1987. Commercial operation in Florida is planned for 1988. O H Materials Canada have proposed the use of an additional Shirco unit for the treatment of soils at a southern Ontario PCB waste site.	
Approval Status PCB trial burns were scheduled for late 1987.	**Availability Status** The OHM infrared unit is available in Canada from O H Materials Canada, Burlington, Ont.	

TABLE A-24 RIEDEL : IDENTITY AND STATUS

Company Name Riedel Environmental Technologies, Inc.	**Technology Name** Riedel Infrared Unit **Technology Type** Shirco Infrared Energy	
Address P.O. Box 5007 Portland, Oregon 97208-5007	**Operating Site** Transportable	**Contact** A. Cross (503) 286-4656
Process Overview Riedel have purchased various Shirco infrared energy units capable of handling from 25 to 250 tonnes per day. Riedel intend to use the units in the cleanup of sludges and soils at hazardous waste sites including those contaminated with PCBs.	**Development Status** Riedel intend to purchase five Shirco units over the next two years. They have received delivery of the first unit (250 tonne per day capacity).	
Approval Status An EPA permit has been submitted.	**Availability Status** Currently Riedel does not have Canadian representation.	

TABLE A-25 SHIRCO : IDENTITY AND STATUS

Company Name Shirco Infrared Systems Inc..	**Technology Name** Shirco Infrared Unit **Technology Type** Shirco Infrared Energy	
Address 1195 Empire Central Dallas, Texas 75247	**Operating Site** Transportable	**Contact** Scott Berdine (214) 630-7511
Process Overview The Shirco system utilizes infrared energy for the destruction of waste materials. The waste feed is conveyed on a woven wire belt to a primary combustion chamber lined with a ceramic fiber blanket. Infrared energy is provided by silicon carbide resistance heating elements grouped in two control zones.The residence time of solids in the primary chamber can be varied from 10 to 180 min. by the belt speed. Temperatures of 1010 ° C are attained in the primary chamber. The secondary chamber is propane fired with a gas residence time of 2 seconds. Exhaust gases pass through a venturi scrubber. The full-scale units have 11 metre stacks.	**Development Status** Shirco operate a permanent pilot plant in Dallas. Shirco have both pilot-scale (45kg/h) and full-scale (4000kg/h) transportable units for demonstration of feasibility of waste destruction. Trial burns have demonstrated the successful destruction of PCB-contaminated soils. Three systems have been constructed and delivered to commercial clients (Haztech, OH Materials, Riedel).	
Approval Status Shirco is permited to conduct PCB trial burns as part of research and development. Trial burns were conducted in January and May of 1987.	**Availability Status** Shirco is in the equipment supply market for transportable hazardous waste incineration services in the US and Canada. Currently Shirco does not have Canadian representation.	

TABLE A-25 (CONT'D) SHIRCO : PROCESS DESCRIPTION

Company Name Shirco Infrared Systems, Inc.

Technology Name Shirco Infrared Incinerator

Technology Type Transportable Infrared Energy System

Waste System

Waste Types Accepted
Primarily designed for solids and sludges. Liquids can be destroyed in a modified secondary chamber.

MAX PCB Content Not specified

MAX Total Chlorine Not specified

Waste Handling System

Solid wastes are pretreated as required and fed to the incinerator on a woven wire conveyor belt.

Destruction System Parameters

Feed Rate Pilot plant : 14 - 45 kg/h
Full scale : 3000 - 9000 kg/h

Operating Mode Continuous

Auxiliary Fuel Propane

Thermal Duty Not specified

Combustion Efficiency >99.9 %

Destruction Temperature
Primary 1010 °C
Secondary 1200 °C

Residence Time (Solids) 180 minutes
Residence Time (Gas) 2 seconds (secondary)

Combustion Air Rate
Not specified

Emission Control System

General Description

Exhaust gases from the secondary chamber pass through a venturi scrubber which removes particulates and cools the combustion gases to the saturation temperature. Exhaust gases are then discharged to the atmosphere through a 11 metre stack.

Exhaust Flow 13 000 Nm^3/h

HCl Removal Rate

Removal efficiency of > 99 %

Particulate Removal Efficiency

Particulate concentrations in the exhaust gases range from 1.0 to 2.3 mg/Nm^3.

Liquid Residue Handling System

Not specified

Solid Residue Handling System

Solid residue from the system is discharged to containers as required.

Services

Power	480 volts/30kVA , 120v/15A
Water	75 L/min
Space	280 m^2
Surface/Shelter	Shelter required for cold/wet weather
Waste Storage	Not specified
Other	

TABLE A-25 (CONT'D) SHIRCO : PERFORMANCE DATA

Company Name Shirco Infrared Systems, Inc.	**Technology Name** Shirco Infrared Incinerator **Technology Type** Transportable Infrared Energy System	
Combustion Efficiency 99.9 % **DRE** Greater than 99.9999 % for PCBs		**Data Source** see below

Air Emissions

Source Discharge at stack **Gas Flow Rate** 44 000 am^3/h at **Gas Temperature** 86 °C	**PCB** **PCDD** Below detection limit **PCDF** (not specified) NO_X **CO** Not specified	**Data Source** PCB trial burns

Liquid Emissions

Source Scrubber effluent **Discharge Rate** Not applicable **Disposal**	**PCB** 0.005 ppb **Other** **PCDD** Below detection limit (not specified) **PCDF**	**Data Source** As above

Solid Wastes

Source Incinerated soil **Discharge Rate** Not specified **Disposal**	**PCB** < 0.2 ppm **PCDD** **PCDF** Below detection limit (not specified)	**Data Source** As above

System Costs

Scope of Services	Transportable commercial waste destruction
Capital Cost/Basis	Not specified
Destruction Cost/Basis	$120 to 200 US/tonne
Minimum Job Size	Not specified

System Mobility

Transport Configuration	Pilot unit : single unit Full-scale : six trailers
MAX Dimensions	Not specified
MAX Load	Total weight : 10 tonnes
Site Requirements	
Lead / Setup Time	Pilot unit : one day Full-scale : not specified

Insurance
Not specified

Site Decommissioning
Not specified

TABLE A-26 SELENCO : IDENTITY AND STATUS

<table>
<tr><td rowspan="2">Company Name Selenco/Sanivan Group.</td><td colspan="2">Technology Name Selenco Transportable MWP2000</td></tr>
<tr><td colspan="2">Technology Type Rotary Kiln</td></tr>
<tr><td rowspan="2">Address 3027 Harvester Rd
Burlington, Ontario L7N 3G7</td><td>Operating Site
Transportable</td><td>Contact
N. Hijazi 1-800-263-6358</td></tr>
<tr><td colspan="2"></td></tr>
<tr><td>Process Overview
Selenco/Sanivan propose to use an Ensco/Pyrotech MWP2000 unit for the destruction of PCB wastes at a site in southern Ontario.</td><td colspan="2">Development Status
See Table A-19 for details on the Ensco/Pyrotech MWP2000.</td></tr>
<tr><td>Approval Status
A permit application has been submitted to the Ontario Ministry of the Environment to operate the MWP2000 unit at a southern Ontario PCB waste site.</td><td colspan="2">Availability Status
Selenco/Sanivan offer the MWP2000 technology for hazardous waste (including PCB) destruction in eastern Canada.</td></tr>
</table>

TABLE A-27 VESTA : IDENTITY AND STATUS

Company Name Vesta Technology Ltd.	**Technology Name** Vesta Mobile Thermal Destruction Units (TDU) **Technology Type** Rotary Kiln	
Address 1670 West McNab Road, Ft. Lauderdale, Florida 33309	**Operating Site** Mobile	**Contact** Tricia Jack (305) 978-1300
Process Overview Vesta Technology have designed and built a mobile rotary kiln system for the thermal destruction of hazardous wastes including PCB wastes. The system has a rotary kiln primary chamber into which liquid and solid wastes are fed. A secondary combustion chamber provides additional residence time. Exhaust gases are controlled by a venturi scrubber and a packed bed scrubber prior to discharge to the atmosphere through a 11 metre stack. The complete system is mounted on one trailer and can be fully operational within 24 hours of arrival on-site.	**Development Status** Vesta have constructed a 1 tonne per hour unit (Vesta 80) which has commercially destroyed non-PCB wastes. Two 2.5 tonne per hour units (Vesta 100) are presently being constructed. Vesta are planning to conduct trial burn tests on PCB wastes during the summer of 1988 in Quebec for Quebec Hydro.	
Approval Status The Vesta 80 Unit is permitted to destroy non-PCB wastes.	**Availability Status** Currently Vesta does not have Canadian representation.	

TABLE A-27 (CONT'D) VESTA : PROCESS DESCRIPTION

Company Name Vesta Technology Ltd.

Technology Name Vesta Thermal Destruction Unit

Technology Type Mobile Rotary Kiln

Waste System

Waste Types Accepted
Liquids,soils and sludges.

MAX PCB Content Not specified

MAX Total Chlorine Not specified

Waste Handling System

Solids are conveyed to ahopper and then ram fed into the kiln. Sludges are pumped into the kiln. Liquid wastes are fed into the kiln through the kiln burner.

Destruction System Parameters

Feed Rate
Vesta 80 TDU - 1800 kg/h
Vesta 100 TDU - 2300 kg/h

Operating Mode Continuous

Auxiliary Fuel Oil / gas

Thermal Duty Vesta 80 - 12MM BTU / Vesta 100 - 12MM BTU

Combustion Efficiency >99.99 %

Destruction Temperature
Primary Not specified
Secondary Not specified

Residence Time (Solids)
Residence Time (Gas) Not specified

Combustion Air Rate
Not specified

Emission Control System

General Description

Flue gases exiting the secondary combustion chamber are cooled prior to the scrubber system. A venturi system uses caustic soda solution to remove acid gases and particulates. This is followed by a countercurrent packed bed tower and a demister.

Exhaust Flow 4300 m^3/h at 65°C

HCl Removal Rate

Vesta 80 - >99 %

Particulate Removal Efficiency

Vesta 80 - Particulate exhaust gas concentration of less than 60 mg/m^3

Liquid Residue Handling System

Scrubber liquid is recirculated.

Solid Residue Handling System

Ash from kiln transfered to drum containers.

Services

Power	Diesel generator or 480 V 3 phase
Water	Not specified
Space	Not specified
Surface/Shelter	Not specified
Waste Storage	Not specified
Other	Not specified

TABLE A-27 (CONT'D) VESTA : PERFORMANCE DATA

Company Name Vesta Technology Ltd.		**Technology Name** Vesta Thermal Destruction Unit **Technology Type** Mobile Rotary Kiln	
Combustion Efficiency 99.99 % **DRE** Greater than 99.99% for non-PCBs			**Data Source** see below
Air Emissions			
Source Discharge at stack **Gas Flow Rate** 4300 m^3/h **Gas Temperature** at 65°C	**PCB** Not specified **NO_X** Not specified **PCDD** Not specified **CO** **PCDF**		**Data Source** Tests on soils contaminated with pesticides, April 1987.
Liquid Emissions			
Source Scrubber effluent recirculated **Discharge Rate** Not applicable **Disposal**	**PCB** Not specified **Other** **PCDD** Not specified **PCDF**		**Data Source** Vesta Technology Ltd.
Solid Wastes			
Source Incinerated soil **Discharge Rate** Not specified **Disposal** Not specified	**PCB** Not specified **PCDD** **PCDF** Not specified		**Data Source** As above
System Costs **Scope of Services** Mobile commercial waste destruction **Capital Cost/Basis** Not specified **Destruction Cost/Basis** $300 to 500 US/tonne **Minimum Job Size** Not specified	**System Mobility** **Transport Configuration** One flat bed trailer **MAX Dimensions** **MAX Load** Not specified **Site Requirements** **Lead / Setup Time** 24 hours		**Insurance** Provided by Ensco **Site Decommissioning** As required.

TABLE A-28 WESTINGHOUSE ELECTRIC CORP : IDENTITY AND STATUS

Company Name Westinghouse Electric Corp. Environmental Systems Div.	**Technology Name** Westinghouse Plasma Arc **Technology Type** Plasma Arc	
Address PO Box 286 Madison, PA 15663	**Operating Site** Mobile	**Contact** M. E. Joseph (412) 722-5714
Process Overview The plasma arc destruction unit is designed to effect thermal decomposition of organic fluids, including askarels and PCB-contaminated mineral oils. The organic fluid and methyl ethyl ketone are injected into an electrically powered plasma arc. The waste is subjected to high temperature and ultraviolet radiation. The arc temperature is approx. 12 000°C and the gas residence time is estimated to be 2 milliseconds. Gases pass to a reactor which is maintained at a temperature of approx. 1100°C. The reactor residence time is about 2 seconds. Gases pass from the reactor to a caustic quench/scrubber which drains to a sump. Scrubber exhaust gas is discharged through a fan to a flare.	**Development Status** A prototype of a commercial-scale unit has been tested. The prototype uses a plasma torch rated at 500 kW with a feed rate of 4 kg/min. A second larger capacity (12 kg/min) system has been built and is currently being tested.	
Approval Status A series of seven PCB tests runs (totalling 18 h) was completed with the prototype unit in March 1986. No permit for commercial destruction of PCBs in Canada or the U.S. have been granted.	**Availability Status** The prototype unit is at the Love Canal site and is not available for commercial operation. The full-scale unit is currently being tested. When commercial, the system will be available in Canada through Westinghouse Canada Inc. Burlington, Ont.	

TABLE A-28 (CONT'D) WESTINGHOUSE EELECTRIC CORP : PROCESS DESCRIPTION

Company Name Westinghouse Electric Corp.

Technology Name Westinghouse Plasma Arc (Pilot Unit)

Technology Type Mobile Plasma Arc

Waste System

Waste Types Accepted
Designed for liquids and pumpable slurries with particle size < 20-30 mesh (<850-600 μm).

MAX PCB Content Not specified

MAX Total Chlorine Not specified

Waste Handling System
Provisions are made for feeding pumpable slurries which meet above particle size criteria. Currently no tests on pumpable slurries.

Destruction System Parameters

Feed Rate
In tests, PCB feed rates ranged from 17 to 26.4 kg/h.

Operating Mode Continuous

Auxiliary Fuel N. A.

Thermal Duty The prototype plasma torch is rated at 500kW

Combustion Efficiency Not applicable, pyrolysis

Destruction Temperature
Torch 12 000°C
Reactor 1100 ° C

Residence Time (Solids) Not applicable
Residence Time (Gas) 2 milliseconds : torch
2 seconds : reactor

Combustion Air Rate Not applicable

Emission Control System

General Description
The pyrolysis gases go to a cautic quench/scrubber. The scrubber off-gases pass through an induced draft fan to a flare. In the event of an emergency shutdown, the gases are diverted through a carbon filter and discharged through a stack.

Exhaust Flow The flare exhaust flow is about 2300 dsm^3/h

HCl Removal Rate
Not specified

Particulate Removal Efficiency
Not specified

Liquid Residue Handling System
Liquid residue is controlled to pH 7.5-8.0. Disposition of scrubber water has not been determined.

Solid Residue Handling System
Solid residues are not generated by the pilot plant.

Services

Power	1 to 2 kWh/kg askarel
Water	50 L/kg askarel
Space	Not specified
Surface/Shelter	14 metre trailer
Waste Storage	Not specified
Other	

TABLE A-28 (CONT'D) WESTINGHOUSE ELECTRIC CORP : PERFORMANCE DATA

Company Name Westinghouse Electric Corp.		**Technology Name** Westinghouse Plasma Arc - Pilot Unit	
		Technology Type Mobile Plasma Arc	
Combustion Efficiency Not applicable **DRE** Greater than 99.9999 % for PCBs			**Data Source** see below
Air Emissions			
Source Flaring of reactor gases **Gas Flow Rate** Approx. 2300 dsm^3/h **Gas Temperature** 60 to 80 ° C after scrubber	**PCB** 3000 to <9.3 ng/m^3 **NO_x** Not specified **PCDD** <380 ng/m^3 **PAH** 2900 to 190 ng/m^3 **PCDF** 1500 to <44 ng/m^3		**Data Source** Tests on PCB fluids were completed March, 1986.
Liquid Emissions			
Source Scrubber effluent **Discharge Rate** 35 L/min **Disposal** Not specified	**PCB** max. 9.4 ppb **PAH** 2000 to 40 ppb **PCDD** < 260 ppt **PCDF**		**Data Source** As above
Solid Wastes			
Source **Discharge Rate** Not applicable - liquid wastes only **Disposal**	**PCB** **PCDD** Not applicable - liquid wastes only **PCDF**		**Data Source** As above
System Costs **Scope of Services** Mobile commercial liquid waste destruction **Capital Cost/Basis** Not specified **Destruction Cost/Basis** Not specified **Minimum Job Size** Not specified	**System Mobility** **Transport Configuration** Single trailer **MAX Dimensions** Not specified **MAX Load** **Site Requirements** Not specified **Lead / Setup Time**		**Insurance** Not specified **Site Decommissioning** Not specified

TABLE A-29 CHEMICAL WASTE MANAGEMENT : IDENTITY AND STATUS

Company Name Chemical Waste Management, Inc.	**Technology Name** Vulcanus I and II	
	Technology Type Incineration-at-Sea	
Address 3003 Butterfield Road, Oak Brook, Illinois 60521	**Operating Site** Currenly based in Europe	**Contact** G. P. Nassos (312) 654-8800

Process Overview

The Vulcanus I and II vessels are chemical tankers designed for the destruction of hazardous waste at sea. The Vulcanus I is equipped with two stern-mounted, vertical liquid injection incinerators and the Vulcanus II is equipped with three similar incinerators. The vessels double-hulled and the waste is stored among a number of tanks in order to minimize release in the event of an accident. The vessels each have a capacity of 3 million litres.

The liquid waste is mixed with auxillary fueland air injected into rotar-cup vortex burners, which fire a cylindrical, combustion chamber. Combustion temperatures range from 1100 to 1600°C. Exhaust gases are released directly to the atmosphere without control. The ash is reincinerated or returned to land to be placed in a landfill.

Development Status

The Vulcanus I and II are commercial incineration vessels. The Vulcanus I was converted from a tanker to an incineration vessel in 1972 and operated for more than a decade burning organic wastes in Europe (North Sea) and the US (Gulf of Mexico and S. Pacific). The Vulcanus II was launched in 1982 and has been operating in the North Sea. The Vulcanus I is currently docked in Belgium and not operating.

Approval Status

Trial burns have been conducted with the Vulcanus I on PCB wastes and chlorinated wastes for the EPA and European authorities. Even though the burns were successful and the technology is considered acceptable, the EPA have not granted Chemical Waste Management a commercial operating permit. Both vessels are permitted to operate in Europe.

Availability Status

The Vulcanus II is currently based in Europe.

TABLE A-30 CHEMICAL DECONTAMINATION : IDENTITY AND STATUS

Company Name Chemical Decontamination Corp.	**Technology Name** CHEMDECON Process **Technology Type** Oil Treatment - Sodium	
Address 5 Riga Lane, Baltic Mews Industrial Park, Birdsboro, PA 19508	**Operating Site** Mobile	**Contact** Bob Layman (215) 582-2766
Process Overview Batches of PCB-contaminated oil are degassed, dewatered and mixed with excess sodium metal. This mixture is heated at 130 to 150°C to enhance reaction. After a defined reaction time, the excess sodium metal is removed by reaction with water. The treated oil is filtered through diatomaceous earth.	**Development Status** Two units have been in commercial operation since 1985 in the U.S.	
Approval Status The system is operated under a national EPA permit.	**Availability Status** Currently Chemical Decontamination do not have Canadian representation.	

TABLE A-31 : CHEM WASTE IDENTITY AND STATUS

Company Name Chemical Waste Management Inc.	**Technology Name** Acurex Process **Technology Type** Oil Treatment - Sodium	
Address 150 West 137 Street Riverdale, Illinois 60627	**Operating Site** Mobile	**Contact** Richard Cartwrite (312) 841-8360
Process Overview The Acurex dechlorination mobile batch process uses a proprietary sodium- based reagent to react with filtered PCB-contaminated transformer oil. The process occurs in a nitrogen atmosphere and at ambient temperature (>20 degrees C). Excess reagent is destroyed by reaction with water. The treated oil is then and filtered and stored for reuse.	**Development Status** Chemical Waste Management purchased the Acurex process in 1985. Previous to this, Acurex Waste Technologies operated the process commercially since 1980.	
Approval Status Prior to September 1985, Acurex Waste Technologies held a national EPA permit. Chem Waste, as the new owner, received a national permit in 1986.	**Availability Status** Currently Chem Waste does not have Canadian representation.	

MOBILE OIL TREATMENT PROCESS

TABLE A-31 (CONT'D) : CHEM WASTE PROCESS DESCRIPTION

Company Name Chemical Waste Management, Inc.

Technology Name Acurex Process

Technology Type Mobile Oil Treatment - Sodium

Waste System

Waste Types Accepted
PCB contaminated mineral oils

MAX PCB Content
10 000 ppm

Waste Handling System
The oil is filtered and dewatered prior to addition of the proprietary reagent. Oils of temperatures less than 20 ° C are heated prior to treatment.

Destruction System Parameters

Feed Rate
3500 L/batch
1-2 hours/batch

Operating Mode
Batch

Process Inputs
Proprietary sodium-based reagent
Nitrogen gas
Water

Reactant Molar Ratios(reagent : chlorine) 50:1 to 100:1

Reaction Temperature 20 ° C

Reaction Time Approximately one to two hours

Reaction Efficiency To less than 2 ppm PCB

Emission Control System

General Description of Emissions

The system is constantly purged with nitrogen gas which is vented to atmosphere. Solid wastes include reaction by-product sludge (sodum chloride and polyproplyene) and filter media.
Water is added to quench excess reagent. Fate of the resultant liquid phase was not specified.

Liquid Residue Handling System

Not specified

Solid Residue Handling System

Not specified

Services

Power 220 V/ 100 amps

Space Not specified

Other

TABLE A-32 : EXCEL TECH IDENTITY AND STATUS

Company Name Excel Tech Inc.	**Technology Name** Acurex Process **Technology Type** Oil Treatment - Sodium	
Address 42475 A Osgood Road Fremont, CA 94539	**Operating Site** Mobile	**Contact** Steve Anderson (415) 659-0404
Process Overview Excel Tech purchased an Acurex mobile process. This system is described in Table A-31.	**Development Status** The process was developed by Acurex Waste Technologies in 1980. Excel Tech purchased a unit and has operated commercially since 1983.	
Approval Status Excel Tech has an EPA permit for Region IX.	**Availability Status** Currently Excel Tech does not have Canadian representation.	

TABLE A-33 : GENERAL ELECTRIC IDENTITY AND STATUS

Company Name General Electric Corporate Research and Development	**Technology Name** GE PEG/KOH Process **Technology Type** Oil Treatment - Precipitation	
Address I River Road Building 2, Room 525 Schnecetady, New York 12345	**Operating Site** Mobile	**Contact** G. Hornek (518) 385-3134
Process Overview The process can be either batch or continuous, and consists of the following procedures: 1) Pumping contaminated oil through a heat exchanger to a reactor, 2) Addition of molten PEG (poly(ethylene glycols)) and ground KOH into the reactor, 3) After stirring the mixture is cooled, precipitating the by-products, 4)The cooled mixture is filtered and centrfuged to remove solids, 5) The recovered oils washed with water, the water decanted, and oil is dehydrated under vacuum. Cleaned oil is the pumped back to the transformer or storage.	**Development Status** A full-scale mobile unit (with an operational through-put of 3400 litres per hour) has been built and tested.	
Approval Status An application for EPA commercial permit has been submitted.	**Availability Status** Currently not commercially available. When commercial, it will be available in Canada through Canadian General Electric, Power Services Div., Burlington, Ontario	

TABLE A-33 (CONT'D) : GENERAL ELECTRIC PROCESS DESCRIPTION

Company Name General Electric

Technology Name GE PEG/KOH Process

Technology Type Oil Treatment - Precipitation

Waste System

Waste Types Accepted PCB contaminated oil

MAX PCB Content
20 000 ppm

Waste Handling System

The proposed system would pump contaminated oil through a heater prior to transfer to the reactor. The reactor would be continuously purged with nitrogen to avoid oxidation of oil by air.

Destruction System Parameters

Feed Rate 3400 L/h

Operating Mode
Batch or continuous

Process Inputs

(By weight relative to transformer oil)
PEG : 1 % as poly(ethylene glycol) methyl ether
KOH : 1 to 6 %

Reactant Molar Ratios 2 equivalent PEG and 6 equivalent KOH per equivalent PCB

Reaction Temperature 100 °C

Reaction Time 10 min at 100 °C
45 min at 60 °C

Reaction Efficiency To less than 2 ppm PCB

Emission Control System

General Description of Emissions

Air emissions would include nitrogen gas and exhaust from vacuum degassing tank.
Liquid emissions would consist of decanted wash waters.
Solid emissions include centrifuged sludge and/or Fuller's earth.

Liquid Residue Handling System

Not specified

Solid Residue Handling System

Not specified

Services

Power

Space Not specified

Other Not specified

TABLE A-33 (CONT'D) : GENERAL ELECTRIC PERFORMANCE DATA

Company Name General Electric Co.	**Technology Name** GE PEG/KOHProcess
	Technology Type Oil Treatment - Precipitation
Treatment Efficiency Treated oils must be less than 2 ppm PCB	**Data Source** GE

Air Emissions

Source	PCB Levels	Data Source
Degassifier exhaust and Nitrogen flushing	Not specified	As above

Liquid Emissions

Source	Volume	Disposal	PCB Level	Other	Data Source
Decanted water	Not specified	Not specified	Not specified	Not specified	As above

Solid Wastes

Source	Volume	Disposal	PCB Level	Other	Data Source
Process sludge and Fuller's earth	Not specified	Not specified	Not specified	Sludge - PCDD and PCDF < 5 ppb Fuller's Earth - Not specified	As above

System Costs

Scope of Services Mobile oil treatment

Capital Cost/Basis

Destruction Cost/Basis Not specified

Minimum Job Size

System Mobility

Transport Configuration Mobile

MAX Dimensions Not specified

Site Requirements Not specified

Lead / Setup Time Not specified

Insurance

Not specified

Site Decommisioning

As required

TABLE A-34 : IT CORP IDENTITY AND STATUS

Company Name International Technologies Corp	**Technology Name** IT Corp. - Niagara Mohawk Process **Technology Type** Oil Treatment - Precipitation	
Address	**Operating Site** Mobile	**Contact**
Process Overview This process uses a mixture of polyethylene glycol/potassium hydroxide/dimethy sulfoxide for dechlorination of PCB.Use of DSMO reduces the reaction time.	**Development Status** IT Corp. purchased the technology from Niagara Mohawk Power Corp. in 1987. Niagara Mohawk had operated the process commercially in the U.S. since 1986.	
Approval Status IT Corp have an application submitted for commercial operation.	**Availability Status** Currently there is no Canadian representation.	

TABLE A-35 : OZONICS IDENTITY AND STATUS

Company Name Ozonics Technology,Inc.	**Technology Name** Ozonics Process **Technology Type** Oil Treatment - Ozone/UV/Ultrasonics	
Address 90 Herbert Ave., P.O. Box 320, Closter , N.J. 07624	**Operating Site** Mobile	**Contact** Ed Pedzy (201) 767-1332
Process Overview Ozonics are developing a mobile oil treatment process which uses a combination of ozone, ultraviolet radiation and ultrasonics.	**Development Status** The process is near-commercial.	
Approval Status Ozonics have submitted an EPA application for commercial operation.	**Availability Status** Currently there is no Canadian representation.	

TABLE A-36 : PPM CANADA IDENTITY AND STATUS

Company Name PPM Canada Inc.	**Technology Name** PPM Process **Technology Type** Oil Treatment - Sodium	
Address 1 Yonge Street, Suite 801, Toronto, Ont. M5E 1E5	**Operating Site** Mobile	**Contact** T. Jillings (416) 364-1919
Process Overview This mobile batch process consists of three stages - pretreatrment, decontamination and clarification. In the pretreatment stage, water is removed from the oil, if necessary, by draining water from the bottom of the oil storage tank. For decontamination, a proprietary organo-sodium reagent is used to dechlorinate PCBs and other chlorinated hydrocarbons. The reaction takes place under a nitrogen atmosphere. Chemical addition continues until the treated oil contains less than 2 ppm PCB. Small amounts of water are added to the decontaminated oil to neutralize excess reagent. The decontaminated oil including alkaline residue is then either disposed of or clarified by filtration for reuse.	**Development Status** The process has been used in Saskatchewan (1983), British Columbia (1984), Nova Scotia , New Brunswick , Quebec (1985) and Ontario (1986).	
Approval Status This process is permitted in seven provinces.	**Availability Status** Three unit are available for treatment of PCB-contaminated oils in Canada.	

MOBILE OIL TREATMENT PROCESS

TABLE A-36 (CONT'D) : PPM CANADA PROCESS DESCRIPTION

Company Name PPM Canada, Inc..

Technology Name PPM Process

Technology Type Mobile Oil Treatment - Sodium

Waste System

Waste Types Accepted
Mineral oil, #6 fuel oil, kerosene

MAX PCB Content

Mineral oil	10 000 ppm
#6 fuel oil	4 000 ppm
Kerosene	4 000 ppm

Waste Handling System

Pumps circulate oil between storage tanks and the mobile treatment system. Organo-sodium reagent is added in batch lots, until treated oil has less than 2 ppm PCB.

Destruction System Parameters

Feed Rate Up to 5000 ppm PCB - 4500 L/h
5000 to 10 000 ppm PCB - 2250 L/h

Operating Mode Batch

Process Inputs
Proprietary solvent, sodium, water, nitrogen gas.

Reactant Molar Ratios Not specified

Reaction Temperature Ambient temperature

Reaction Time 30 min to 1.0 h per batch

Reaction Efficiency To less than 2 ppm PCB

Emission Control System

General Description of Emissions

A sludge is formed during reaction of the proprietary reagent with PCB, inhibitors, thiols and chlorinated hydrocarbons. Liquid wastes include water which is separated from oil prior to treatment, and water which is added at the last stage of the process to react with excess reagent.

Air Emission Handling System

A carbon filter is connected to the solvent storage tank vent. Demisters and activated carbon filters are present on all storage/reaction tanks in the mobile unit.

Liquid Residue Handling System

Waste oil and alkaline residue disposed of by liscenced disposal company.

Solid Residue Handling System

PCB-exposed rags, clothing, etc. are drummed and disposed according to provincial regulations.

Services

Power	480 volts/ 3 phase / 150 amps
Space	Provision for two 14-metre trailers
Other	Laboratory for PCB gas chromatograph analysis

TABLE A-36 (CONT'D) : PPM CANADA PERFORMANCE DATA

Company Name PPM Canada, Inc.	**Technology Name** PPM Process
	Technology Type Mobile Oil Treatment - Sodium
Treatment Efficiency Treated oils must be less than 2 ppm PCB	**Data Source** PPM Canada

Air Emissions

Source	PCB Levels	Data Source
1. Solvent tank vent 2. Degassifier 3. Vented nitrogen gas	1. Below detection limit (not specified) 2. Not specified 3. Below detection limit (not specified)	As above

Liquid Emissions

Source	Volume	Disposal	PCB Level	Other	Data Source
1. Decanted water pretreatment 2. Oily-water emulsion	1. Source dependent 2. 1 to 2 % of oil treated	1. PCB concentration dependent 2. PCB concentration dependent	1. < 2 ppm 2. Not specified	1. Not specified 2. PCDD, PDDF not detected	As above

Solid Wastes

Source	Volume	Disposal	PCB Level	Other	Data Source
1. Reaction by-product sludges 2. Rags and clothing	1. 18 L/1000 L treated 2. Variable	1. PCB concentration dependent 2. Secure landfill	1. < 2 ppm 2. < 50 ppm	1. & 2. PCDD, PDDF not detected	As above

System Costs

Scope of Services Mobile oil treatment

Capital Cost/Basis Not specified

Destruction Cost/Basis $ 0.88 to 5.50 / L

Minimum Job Size None

System Mobility

Transport Configuration Mobile

MAX Dimensions Two 14-metre trailers

Site Requirements Not specified

Lead / Setup Time Less than one day

Insurance

General liability
Environmental impairment

Site Decommisioning

Not specified

TABLE A-37 : RONDAR IDENTITY AND STATUS

Company Name Rondar Inc.	**Technology Name** Ont. - B.C. Hydro Process **Technology Type** Oil Treatment - Sodium	
Address 333 Centennial Parkway N Hamilton, Ontario L8E 2X6	**Operating Site** Mobile	**Contact** Norman Stewart (416) 561-2808
Process Overview The process is based on the dechlorination of PCBs with sodium. The treatment system is mounted on a 14-metre trailer, and includes the following components: 1) a feed system to transfer PCB-contaminated mieral oil to either of two reaction vessels within which sodium is added under a nitrogen atmosphere. 2) a heater to raise the temperature of the oil and facilitate reaction of the sodium with PCB. 3)a gas emission control system which includes an exhaust vent condenser and two activated carbon filters. 4) a centrifuge and filtration system to remove insoluble components. The treatment process is carried out in batches within each reaction vessel. Sodium reacts with PCB to form sodium chloride and hydrocarbon residues. The resultant product is centrfuged and filtered to result in PCB-free oil (i.e. less than 2 ppm PCB).	**Development Status** Ontario Hydro and B.C. Hydro developed this system, Rondar market the technology and services as licencees of Ontario and B.C. Hydro. Testing of the system was performed in 1985, during which approximately 3280 L of 120 ppm PCB oil, 15 500 L of 700 ppm PCB oil and 3000 L of 7000 ppm PCB oil were processed to less than 2 ppm PCB. The process has been in commercial operation since 1986.	
Approval Status This process is permitted in Nova Scotia, Quebec and Ontario.	**Availability Status** This process is available for commercial operation in Canada.	

TABLE A-37 (CONT'D) : RONDAR PROCESS DESCRIPTION

Company Name Rondar Inc.

Technology Name Ont. - B.C. Hydro Process

Technology Type Mobile Oil Treatment - Sodium

Waste System

Waste Types Accepted

PCB contaminated mineral oils

MAX PCB Content

7000 ppm (upper limit tested)

Waste Handling System

An oil feed pump is used to direct the oil through two oil heaters and one degassifier prior to transfer to the batch reaction vessels.

Destruction System Parameters

Feed Rate 750 L/h

Operating Mode Batch

Process Inputs

For 6000 L of oil with 200 ppm PCB : 8 kg sodium
0.4 cylinders nitrogen
6 kg water

Reactant Molar Ratios Not specified

Reaction Temperature 100 ° C

Reaction Time 15 to 45 min

Reaction Efficiency To less than 2 ppm PCB

Emission Control System

General Description of Emissions

Inert system nitrogen is cooled to condense entrained oil and subsequently passed through two carbon filters. Degassifier condensate is mostly water, contaminated with some oil. Condensated is reused in the process.

Solid wastes consist of : reaction by-products (sodium chloride and polyphenylene) and carbon canisters from the nitrogen gas treatment system.

Liquid Residue Handling System

Nitrogen condensate collected and recycled. Degassifier condensate collected and recycled and tested for PCBs before discharge.

Solid Residue Handling System

Centrifuge sludge is pumped out after completion of batch process. Sludge is stored in a waste storage tank. Carbon canisters are placed in approved storage facilities pending final disposal as PCB waste.

Services

Power Not specified

Space Area 20 m X 12 m for one 14-metre trailer

Other

TABLE A-37 (CONT'D) : RONDAR PERFORMANCE DATA

Company Name Rondar, Inc.	**Technology Name** Ont.- B.C. Hydro Process
	Technology Type Mobile Oil Treatment - Sodium
Treatment Efficiency Initial PCB content (50 - 7000 ppm) treated to less than 2 ppm.	**Data Source** Rondar

Air Emissions

Source	PCB Levels	Data Source
1. System nitrogen 2. Condenser vent	1. < 1 $\mu g/m^3$ prior to activated carbon 2. Not specified	As above

Liquid Emissions

Source	Volume	Disposal	PCB Level	Other	Data Source
1. Exhaust vent condensate 2. Nitrogen condensate	1. 60 mL/1500 L batch 2. 2 g/1500 L batch	Recycled	1. < 2 ppb: water phase - <2 ppm:oil phase 2. Not specified	1.Chlorinated benzene in oil <200 ppm 2. Not specified	As above

Solid Wastes

Source	Volume	Disposal	PCB Level	Other	Data Source
1. Centriguge residue 2. Carbon canisters	1. 25 L/ 1500 L batch 2. Not specified	1. Secure landfill 2. As PCB waste	1. < 2 ppm 2. Not specified	1. 50% oil, 36% NaCl, 4% NaOH 2. Not specified	As above

System Costs

Scope of Services Mobile oil treatment

Capital Cost/Basis $500 000 Cdn

Destruction Cost/Basis $ 1.50 - 2.50 / L

Minimum Job Size None

System Mobility

Transport Configuration Mobile

MAX Dimensions 14m(L)x2.6m(W)X4m(H)

Site Requirements Not specified

Lead / Setup Time Less than one day

Insurance

Not specified

Site Decommisioning

Not specified

TABLE A-38 SELENCO : IDENTITY AND STATUS

Company Name Selenco/Sanivan Group	**Technology Name** Selenco PCBD Process **Technology Type** Oil Treatment - KOH	
Address 3027 Harvester Road, Burlington, Ontario L7N 3G7	**Operating Site** Mobile	**Contact** N. Hijazi (416) 682-3366
Process Overview The PCBD process is a chemical dechlorination process coupled to an oil reclamation process. The PCB-contaminated mineral oil is treated by injecting a KOH reagent into the oil stream at elevated temperatures to cause a thermochemical reaction. The dechlorination agent is non-explosive and non-metallic. Oil can be treated continuously in either energized or de-energized transformers, or may be processed in batches with an option of having an energized or de-energized retrofill performed on the transformer. The reagent is separated from the oil and resulting salt by means of a centrifuge. The oil is reclaimed to ASTM required dielectric properties with the application of heat, Fuller's earth, vacuum and final filtration.	**Development Status** The process has been in commercial operation in the U.S. (Transformer Consultants) since 1982 and in Canada since 1986.	
Approval Status This process has been in commercial operation in the U.S. since 1982. The system is permitted in Quebec and an application has been submitted in Ontario.	**Availability Status** Two units are available for commercial service. One is based in Burlington to service Ontario and Western Canada, the other is based in Montreal to service Quebec and the Eastern Provinces.	

MOBILE OIL TREATMENT PROCESS

TABLE A-38 (CONT'D) : SELENCO PROCESS DESCRIPTION

Company Name Selenco/Sanivan Group

Technology Name Selenco PCBD Process

Technology Type Mobile Oil Treatment - Sodium

Waste System

Waste Types Accepted Transformer oil, hydraulic oil lubricants

MAX PCB Content
3300 ppm PCB

Waste Handling System

Oil is circulated between transformers or storage tanks by pumps. The PCBD process is housed in two separate vehicles, one with the PCBD dechlorinator and a climate controlled laboratory while the other houses the oil reclamation unit. The dechlorination unit consists of a reagent pump, reagent storage tanks, a 1360 L capacity reactor, a centrifuge and a heat exchanger. The proprietary reagent is added in excess until the treated oil is less than 2 ppm PCB.

Destruction System Parameters

Feed Rate Variable with a maximum of 95 L/h

Operating Mode
Batch and continuous

Process Inputs
Proprietary reagent, Fullers earth.

Reactant Molar Ratios Not specified

Reaction Temperature 150 ° C

Reaction Time Depends on volume and PCB concentration

Reaction Efficiency To less than 2 ppm PCB

Emission Control System

General Description of Emissions

Solid wastes are produced in the form of spent filter media and sludge. These solid wastes contain non-chlorinated substances, inorganic chlorides, water and a small amount of treated mineral oil. The PCBD reagent is continually reused in the processing until the reaction appears to be less effective and the 2 ppm discharge oil is difficult to achieve. The spent reagent is separated and pumped into drums which are manifested for disposal. The Fullers earth contacts the oil after the destruction of PCBs.

Air Emission Handling System

The dechlorination is a closed loop process. Vented gases are routed to a common filter and an oil mist eliminator. These gases have not been contacted with PCBs in the process.

Liquid Residue Handling System

Secure storage and disposal according to PCB content.

Solid Residue Handling System

Solids are removed by centrifuging and drummed. PCB-exposed rags and clothes are drummed for disposal.

Services

Power 550 volts/ 3 phase / 60 cycle, 60 amps

Space Not specified

Other System has provision for use of 1600 L spill pan.

TABLE A-38 (CONT'D) : SELENCO PERFORMANCE DATA

Company Name Selenco/Sanivan Group	**Technology Name** Selenco PCBD Process
	Technology Type Mobile Oil Treatment - Sodium
Treatment Efficiency Treated oils must be less than 2 ppm PCB	**Data Source** Selenco/ Sanivan

Air Emissions

Source	PCB Levels	Data Source
1. Vacuum pump exhaust 2. Oil heater exhaust 3. Storage, recovery and centrifuge vents	1. Below detection limit (not specified) 2. Below detection limit (not specified) 3. Below detection limit (not specified)	As above

Liquid Emissions

Source	Volume	Disposal	PCB Level	Other	Data Source
Spent reagent	Variable	Secure landfill	< 2 ppm	PCDD, PDDF not detected	As above

Solid Wastes

Source	Volume	Disposal	PCB Level	Other	Data Source
1. Discharge cartridge filter	1. Variable	1. Secure landfill	1. Below detection limit	1. PCDD, PDDF not detected	As above
2. Rags and clothing	2. Variable	2. Secure landfill	2. < 50 ppm	3. PCDD, PDDF not detected	
3. Fuller's earth	3. Variable	3. PCB level dependent	3. 0.5 ppm		

System Costs

Scope of Services Mobile oil treatment

Capital Cost/Basis Not specified

Destruction Cost/Basis Not specified

Minimum Job Size Not specified

System Mobility

Transport Configuration Mobile

MAX Dimensions One 14 meter trailer and one 7 meter box truck

Site Requirements Not specified

Lead / Setup Time Less than one day

Insurance

General liability

Site Decommisioning

Not specified

TABLE A-39 : SUN ENVIRONMENTAL IDENTITY AND STATUS

Company Name Sun Environmental Ltd.	**Technology Name** PCBX Process **Technology Type** Oil Treatment - Sodium	
Address 3100 Steeles Ave East., Suite 603 Markham, Ontario L3R 8T3	**Operating Site** Mobile	**Contact** Jack McMillan (416) 479-1433
Process Overview Using a continuous feed process, PCB-contaminated mineral oil is pumped through a heating system to a mixer where a proprietary sodium-based reagent is added. The mixture passes into a reaction chamber, then into a recovery system consisting of heat exchangers, filters, a centrifuge and a vacuum evaporator. The proprietary reagent strips the chlorine atoms from the PCB molecule, generating a chloride salt and polyphenylene.	**Development Status** The first prototype was developed in 1979. To date, over 75 million litres of PCB-contaminated oil have been treated in more than 550 contracts in the U.S. and Canada.	
Approval Status This process is permitted in all provinces, except Alberta.	**Availability Status** The PCBX process is available on a contract basis or on a purchase basis in Canada.	

TABLE A-39 (CONT'D) : SUN ENVIRONMENTAL PROCESS DESCRIPTION

Company Name Sun Environmental

Technology Name PCBX Process

Technology Type Mobile Oil Treatment - Sodium

Waste System

Waste Types Accepted
PCB contaminated oil

MAX PCB Content
Design : 10 000 ppm
Preferable working limit : 2000 ppm

Waste Handling System

Oils from transformers are pumped directly to the mobile treatment unit. Waste contaminated lubricating oils must have various interfering additives removed.

The system is also capable of treating oil from energized transformers.

Destruction System Parameters

Feed Rate 2800 L/h

Operating Mode
Batch and continuous

Process Inputs
Proprietary reagent, Fullers earth, nitrogen gas, cartridge filters

Reactant Molar Ratios Not specified

Reaction Temperature 100 to 140 ° C

Reaction Time Not specified

Reaction Efficiency To less than 2 ppm PCB

Emission Control System

General Description of Emissions

Solid wastes consist of reaction products (sodium chloride, polyphenylene), cartridge filters and Fuller's earth.
No liquid wastes are formed .

Liquid Residue Handling System

No liquid residues are formed.

Solid Residue Handling System

More than 2/3 of the solid wastes are consistently less than 2 ppm PCBs. Such wastes are sent to landfill. Another 1/3 of the wastes are less than 20 ppm PCBs, and can be treated to less than 2 ppm if desired. Disposal inaccordance with local regulations

Services

Power 600 volts/ 3 phase 100 amps/ 30 kVA

Space For a trailer and mobile laboratory

Other Not specified

TABLE A-39 (CONT'D) : SUN ENVIRONMENTAL PERFORMANCE DATA

Company Name Sun Environmental Ltd.	**Technology Name** PCBX Process
	Technology Type Mobile Oil Treatment - Sodium
Treatment Efficiency Treated oils must be less than 2 ppm PCB	**Data Source** Sun Enviromental

Air Emissions

Source	PCB Levels	Data Source
1. Degassifier exhaust 2. Nitrogen flushing	1. Below detection limit (not specified) 2. Below detection limit (not specified)	As above

Liquid Emissions

Source	Volume	Disposal	PCB Level	Other	Data Source
No liquid wastes	Not applicable	Not applicable	Not applicable	Not applicable	As above

Solid Wastes

Source	Volume	Disposal	PCB Level	Other	Data Source
1. Process sludge	1. 5 L/100 L oil treated	1. Secure landfill	1. <5 ppm	1. polyphenylene	As above
2. Fuller's earth, filter cartridges	2. Not specified	2. Not specified	2. Not specified		

System Costs

Scope of Services Mobile oil treatment

Capital Cost/Basis $400 000 to $700 000 US

Destruction Cost/Basis $1.00 - 2.25 /L US

Minimum Job Size $50 000 Cdn

System Mobility

Transport Configuration Mobile

MAX Dimensions Two trailers and supply van

Site Requirements Not specified

Lead / Setup Time One day

Insurance $10 000 000 US

Site Decommisioning As required

TABLE A-40 : TRANSFORMER CONSULTANTS IDENTITY AND STATUS

Company Name Transformer Consultants	**Technology Name** PCBD Process **Technology Type** Oil Treatment - KOH	
Address P.O. Box 4724 Akron, Ohio 44310	**Operating Site** Mobile	**Contact** Not specfied
Process Overview Oil contaminated with PCB is drawn from a storage tank or a transformer by use of a centrifugaal oil booster pump. Proprietary reagent is drawn from storage and injected into the oil on the suction side of the inlet pump. The amount of reagent is predetermined on the basis of prior analysis for PCB concentration in oil. The reagent and oil are heated in an oil fired heater, then injected into a 1140 litre reactor. Following analytical confirmation of PCB destruction, the dechlorinated oil, reaction by-products, and reagent are separated by a centrifuge. The reagent is automatically returned to the storage tank for reuse, or tested and disposed of according to the scope of approval. The dechlorinated oil is then cooled in a heat exchanger that provides reclamation temperatures of approx. 95°C and recovers energy for heating the reagent tank. The oil is then reclaimed in an oil purifier consisting of dual filtering tanks, a vacuum dehydrator, and a final filter with disposable paper cartridges. A discharge pump returns the oil to the desired location.	**Development Status** Development of this system was completed in 1981, and commercial operations started in 1982. There are three units in operation and more than 500 commercial applications were successfully completed.	
Approval Status Transformer Consultants have an EPA commercial permit.	**Availability Status** The PCBD process is available in Canada through the Selenco/Sanivam Group.	

TABLE A-41 : ACUREX IDENTITY AND STATUS

Company Name Acurex	**Technology Name** Acurex Solvent Wash **Technology Type** Solvent Extraction - Soils	
Address P.O. Box 13109 Research Triangle Park, NC 27709	**Operating Site** Transportable	**Contact** Not specfied
Process Overview The Acurex process extracts PCBs from soils using a mixture of pure hexane, freon and a proprietary solventy blend. The system consists of a soil contactor, dirty and clean solvent tanks, a solvent reclamation system, steam generator and ancillary pipng equipment. It also includes vent condensers and an activated carbon absorption system for air pollution control.	**Development Status** A pilot system was built and tests on PCB-contaminated soils were conducted in 1985. Soil containing up to 1980 ppm PCB was successfully treated to less than 2 ppm PCB. The results of the prototype tests are unknown.	
Approval Status Currently no permits or permit applications submitted.	**Availability Status** The technology is currently not available commercially.	

TABLE A-42 : BATTELLE PNW IDENTITY AND STATUS

Company Name Battelle Pacific Northwest Laboratory	**Technology Name** Battelle ISV **Technology Type** Vitrification	
Address 2326 Lloyd Center, Portland, OR 97232	**Operating Site** Transportable	**Contact** V.F. FitzPatrick
Process Overview Vitrification involves stabilization of contaminated soils by melting. At the high temperatures (>1700°C) provided by electrodes the process pyrolyzes organic materials. The products of pyrolysis diffuse to the surface. Any off-gases must be collected and treated. The molten soil or sediment is allowed to cool to a crystalline form. Treatment costs are estimated to range from $250 to $500 US per m3.	**Development Status** An engineering-scale test was conducted by Battlle PNW for the Electric Power Research Institute on soil containing 500 ppm. Based on the PCB content of the uncontrolled off-gases the destruction efficiency for the PCBs was greater than 99.9%. The U.S. EPA are interested in applying this technology to the treatment of PCB contaminated sludges.	
Approval Status Currently no permits or permit applications submitted.	**Availability Status** The technology is currently not available commercially.	

TABLE A-43 : BIOCLEAR CORP IDENTITY AND STATUS

Company Name Bioclear Corp.	**Technology Name** Bioclear **Technology Type** Biodegradation	
Address 9700 Richmond Ave., Suite 140 Houston, TX 77042	**Operating Site** Transportable	**Contact** R. Frias (713) 974-7516
Process Overview The process is currently in the research and development stage. Research is concentrating on identifying microbes and enzymes and the specific processes which will most efficiently degrade the contaminated soils or sludges in-situ.	**Development Status** Bioclear have applied for an EPA research and development permit to conduct tests with PCB-contaminated soils. They intend to develop this technology so that it may be offered commercially.	
Approval Status An EPA research and development permit has application has been submitted.	**Availability Status** Currently Bioclear does not have Canadian representation.	

TABLE A-44 : DETOX IDENTITY AND STATUS

Company Name Detox Industries, Inc.	**Technology Name** Detox **Technology Type** Biodegradation	
Address 12919 Dairy-Ashford Sugar Land, TX 77478	**Operating Site** Transportable	**Contact** J. Dailey (713) 240-0892
Process Overview The Detox process involves the adaptation of naturally-occurring micro-organisms to perform specific biodegradation of hazardous wastes including PCBs. The process initially involves the production of micro-organisms and then the application of these micro-organisms to the contaminated soil. The objective is the reduction of the contaminant without the production of any harmful by-products. Treatment can be applied on-site with application of microbes in-situ or with transfer of the soil to a tank in which biodegradation will take place.	**Development Status** The process has progressed through research and development and is available commercially. The Detox process has commercially treated PCP-creosote wastes, demonstrated the feasibility of treatment of PCB-contaminated sediments and currently is commercially treating PCB-contaminated sludge and soil.	
Approval Status Detox have an EPA commercial permit to apply this process.	**Availability Status** Currently Detox does not have Canadian representation.	

ALTERNATIVE PCB SOLID WASTE TREATMENT TECHNOLOGIES

TABLE A-45 : GALSON IDENTITY AND STATUS

Company Name Galson Research Corp.	**Technology Name** Terraclean-Cl	
	Technology Type Chlorine Removal	
Address	**Operating Site** Transportable	**Contact** Not specified
Process Overview The Terraclean-Cl process of Galson involves the chemical dehalogenation of PCBs. Soil is reacted at 150°C with a mixture of polyglycols, potassium hydroxide and dimethyl sulfoxide. At the completion of the reaction the bulk of the reagent is decanted, the soil washed with water to remove residual reagent and dechlorinated by-products.	**Development Status** A patent has been granted for this process. Pilot-scale testing of dioxin- and PCB-containing wastes have been conducted. Future plans are to build a full-scale prototype for further testing.	
Approval Status Curently no permits or permit applications submitted.	**Availability Status** This process is not available commercially.	

TABLE A-46 : MODAR IDENTITY AND STATUS

Company Name Modar, Inc.	**Technology Name** Modar Process **Technology Type** Supercritical Water Oxidation	
Address 14 Tech Circle, Natick, MA 01760	**Operating Site** Transportable	**Contact** W. Killilea (617) 655-7741
Process Overview The process is based on the high solubility of organics and gases in supercritical water. Organic wastes, air and supercritical water form a homogeneous phase at a temperature of 600°C. Chlorinated organics are rapidly oxidized producing carbon dioxide, HCl and water. The process effluent is cooled and gas and liquid phases are separated and depressurized for discharge. Steam is generated as a by-product of the process.	**Development Status** A continuous-flow bench scale system was constructed in 1980. A pilot-scale system was constructed in 1984 and was used for field demonstrations of the process during 1985. Future status of development is unknown.	
Approval Status Curently no permits or permit applications submitted.	**Availability Status** This process is not available commercially.	

TABLE A-47 : O H MATERIALS IDENTITY AND STATUS

Company Name O.H. Materials, Inc.	**Technology Name** OHM Methanol Extraction	
	Technology Type Solvent Extraction - Soils	
Address P.O. Box 551, Findlay, Ohio 45810	**Operating Site** Transportable	**Contact** (419) 423-3526
Process Overview The OHM methanol extraction process involves slurring ground and predried soil with methanol, separating and redrying the treated soil and solvent for resale. The cleanup employs activated carbon, which is incinerated as a hazardous waste. The cleaned soil is land farmed for degradation of any residual methanol. Waste waters are treated in a holding pond. In field tests, two-stage extraction was used to reduce the PCB concentration to 25 ppm.	**Development Status** The process was field tested in 1985 on PCB-contaminated soil. Further testing and development are required before it can be considered a proven technology.	
Approval Status Curently no permits or permit applications submitted.	**Availability Status** This process is not available commercially.	

TABLE A-48 : OAK RIDGE LAB IDENTITY AND STATUS

Company Name Oak Ridge National Laboratory	**Technology Name** Soilex	
	Technology Type Solvent Extraction - Soils	
Address Oak Ridge, TN 37831	**Operating Site** Transportable	**Contact** Not specified
Process Overview The Soilex process developed by Oak Ridge National Laboratory uses kerosene and water to extract PCBs from soils. The extent of PCB extration from the soil is a function of soil-water-kerosene ratios and mixing times. A three-stage pilot plant reduced mPCB in soil to 12 ppm. The process generates a concentrated PCB waste.	**Development Status** A pilot plant was tested in 1984 by Oak Ridge National Lab. Current status of the technology is known.	
Approval Status Curently no permits or permit applications submitted.	**Availability Status** This process is not available commercially.	

TABLE A-49 : SRH ASSOCIATES IDENTITY AND STATUS

Company Name SRH Associates, Inc.	**Technology Name** SRH Vapour Extraction **Technology Type** Fluidized Bed	
Address 123 NE Third Ave., Portland, OR 97232	**Operating Site** Transportable	**Contact** J. Spencer (503) 232-0824
Process Overview SRH have developed a fluidized bed technology for application to PCB-contaminated soils. Organic material in the soil is vaporized in a transportable 10 000 kg/h fluidized bed furnace and the off-gases condensed and the PCBs collected in a bank of activated carbon filters. The filters containing the separated PCBs then require final destruction by incineration.	**Development Status** A prototype system has been built which will undergo tests prior to commercial operation at a waste site in Alaska. SRH also intend to construct a larger unit for commercial operation.	
Approval Status Curently a permit has been submitted to perform trial tests.	**Availability Status** Currently SRH do not have Canadian representation..	